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MAURICE

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NOTES ET COMMENTAIRES

Nous félicitons Mr. Vivian Olivier de sa récente promotion comme directeur d'usine à Savinia Ltd. Monsieur Olivier remplace Monsieur Nadal qui a pris une retraite bien méritée après 39 années de service sur le même établissement. A Deep River c'est Monsieur René Raffray qui a pris la succession de Monsieur René Rey.

La fabrique de sacs de Quatre-Bornes se trouve maintenant sous le contrôle d'un Comité dont le Directeur d'Agriculture en est le président. Elle est dirigée par Mr. Marcel Souchon qui a laissé son poste de Secrétaire du Syndicat des Fibres à Monsieur Abel de Robillard.

MM. Jean Baissac chimiste de Beau Séjour et Hervé Brown chef employé de Gros Bois ont reçu tous les deux des commissions d'officiers dans le corps de Pionniers formé à Maurice. Ils ont quitté la colonie dans le courant de Janvier.

On étudie en ce moment un projet pour réorganiser le cours d'enseignement du Collège d'Agriculture. Il serait question d'avoir deux sections distinctes : après une première année d'étude générale, certains étudiants se spécialiseraient en Agronomie et d'autres en Technologie. Le nouveau programme comporterait entre autres changements un stage sur les propriétés pour étudier les travaux des champs, et pour la section de technologie un cours plus avancé de mécanique et de mathématique.

La Société Royale des Arts et des Sciences a célébré le 18 Décembre dernier le centenaire de la mort de Julien Desjardins le fondateur de la Société. C'est sur sa propriété d'Argy que le célèbre naturaliste faisait ses recherches et avait un musée qu'il légua à la colonie.

Des vols répétés ayant été commis dans les champs du Département d'Agriculture des mesures draconiennes ont été prises pour mettre un point final à cet état de chose. Ainsi les écriteaux suivants ont été installé à toutes les routes traversant les terrains du Département : " Dans le but " de prévenir l'activité des malfaiteurs des fils de clôture au Réduit, ainsi " qu'un certain nombre de fils camouflés et de pièges sont fortement élec- " trifiés la nuit. De plus des gardiens armés et de tempérament agressif " ont pour mission de surveiller le Département et d'arrêter quiconque y " entrerait sans autorisation après les heures de travail. Tout délinquant " sera poursuivi."

MM. C. A. O'Connor du Département d'Agriculture et H. C. King du

Département des Forêts sont en ce moment en mission à Rodrigues où ils s'occupent d'une délimitation des terres devant servir à l'agriculture et au reboisement.

Le Département d'Agriculture a fait récemment paraître les brochures suivantes : " Agricultural Census 1940 " par M. M. Kœnig, " Potato Culture in Mauritius " par M. A. N. Coombes, le Bulletin No. 17 de la Station de Recherches sur la canne à sucre contenant un article par M. G. C. Stevenson sur la Uba Marot et un autre de M. N. Craig sur les nouvelles variétés de canne.

Des incendies causant des dégats assez sérieux ont éclaté vers la fin de l'année dernière dans les magasins de Beau Vallon et l'étable de Belle Mare. A ce propos nous lisons dans le Bulletin Agricole de Novembre 1910 : " Un incendie dû à des causes accidentelles a complètement dé- " truit dans la nuit du 29 Octobre dernier l'usine de Constance Mérandon " Flacq. "

Voici quelques opinions émises dans le " Testament Agricole " de Sir Albert Howard, C. I. E., M,A. :

" La décomposition (humique) est la source même de la vie saine."

" Les plantes qui croissent dans un sol riche en humus peuvent se " défendre contre les pestes et les maladies sans l'aide adventive et oné- " reuse des entomologistes et des mycologistes munis de leurs pompes et " de leurs poudres. "

A propos de l'emploi des engrais chimiques : " Les engrais artificiels conduisent inévitablement à une nutrition artificielle, à des animaux artificiels et finalement à des hommes et à des femmes artificiels. " Ainsi nous voilà délivrés de la responsabilité de nos artifices.

A Ceylan, on est contraint d'employer le poonac comme engrais en conséquence de la réduction qu'a subie l'exportation de ce produit du fait de la guerre. Sa teneur en éléments fertilisants est la suivante : 3 à 5% d'azote, 1.5% d'acide phosphorique et 1.3 o/o de potassse.

Dans le rapport pour l'année 1938 sur l'Agriculture et l'Elevage dans l'Inde, on relate que le maïs peut dans certaines conditions favorables fixer l'azote de l'atmosphère. Mais on ne décrit ni les conditions ni le processus qui font de cette céréale une rivale inattendue des légumineuses.

Le " *Rhodesia Agricultural Journal* " de septembre de l'année dernière présente un nouveau légume : Le soja. " C'est, " débute-t-il avec vérité, " sans conteste la plante vivrière la plus importante du monde ". C'est un aliment que l'on peut substituer à la viande, au lait et aux œufs au point de vue nutritif. On estime qu'une livre de soja équivaut à 2 1/2 livres de viande. Voilà de quoi troubler profondément les végétariens !

L'ADAPTATION DES NOUVELLES VARIÉTÉS DE CANNES AUX DIFFÉRENTES LOCALITÉS DE MAURICE.*

G. C. STEVENSON

Généticiste, Station de Recherches sur la Canne à Sucre.

Etant donné que la pratique locale favorise un nombre important de repousses et que la superficie replantée chaque année est par conséquent relativement faible, il est compréhensible que la propagation d'une nouvelle variété de canne ne puisse s'effectuer qu'assez lentement. Pour cette raison, les administrateurs sont naturellement prudents et ne plantent une variété nouvelle sur une grande échelle qu'après avoir acquis, la quasi certitude de sa supériorité. Les essais de variétés entrepris par la Station de Recherches sur la Canne à Sucre revêtent conséquemment une grande importance. Les succès des méthodes employées par la Station de Recherches sur la Canne à Sucre depuis plusieurs années sont confirmés par les résultats remarquables obtenus avec la M. 171/30, la M. 72/31 et la M. 134/32 qui sont actuellement plantées sur une échelle commerciale.

Comme tous les planteurs le savent, les conditions sous lesquelles on cultive la canne à sucre à Maurice varient considérablement du point de vue pluviométrie, altitude et type de sol. De plus il faut tenir compte d'autres facteurs importants tels que les attaques sporadiques des parasites ou des maladies. On ne doit donc pas s'étonner de constater qu'une variété donnant de bons résultats dans une certaine région soit moins bonne ailleurs. Les nouvelles variétés, avant d'être livrées au public, sont soumises à des essais comparatifs sur plusieurs établissements sucriers représentant à la fois les conditions normales de culture ainsi que la diversité des climats. C'est ainsi que la constatation d'un échec avec une variété quelconque dans un essai peut fournir par ailleurs une indication utile. Le comportement de plusieurs types de cannes sous des conditions déterminées peut actuellement être prévu de sorte que certaines nouvelles variétés ne sont essayées que dans les régions jugées les plus aptes à leur convenir.

Après obtention de plus amples renseignements au sujet du comportement de chaque type de canne sous les différents climats de l'île, nous espérons produire des variétés nouvelles s'adaptant mieux à des conditions particulières.

Il y a actuellement dans les essais entrepris sur différents établissements sucriers dix nouvelles variétés qui sont comparées aux anciennes

* Traduction

variétés types ainsi qu'aux variétés plus récentes déjà livrées au public par la Station de Recherches sur la Canne à Sucre. Il est probable que quelques unes de ces variétés auront une grande valeur sous des climats les plus variés. La possibilité de livrer certaines de ces variétés au public ne pourra être envisagée qu'après conclusion des essais à être recoltés en 1941. Pour le moment il suffit d'étudier les trois variétés M. 171/30, M. 72/31 et M. 134/32 sous les différentes conditions existant à Maurice afin de pouvoir en retirer le maximum d'avantages.

La M. 171/30 provenant de la R.P. 6 et de la M. 27/16 est apparentée aux anciennes variétés 131 P et Guinghan et ne contient pas de sang sauvage. Quoique en général la germination ait été bonne dans nos essais comparatifs de variétés, elle a été parfois plutôt défectueuse en raison d'une infection des boutures par la " maladie de l'ananas ". Le traitement des boutures avec une solution fongicide est donc recommandé. Cette variété souche très bien et les jeunes plantations se distinguent aisément par le port érigé caractéristique des feuilles. Sous des conditions favorables la pousse est rapide et se prolonge tard dans la saison. Les résultats des essais comparatifs de variétés ainsi que ceux de la grande culture ont demontré que la M. 171/30 ne convenait pas aux régions sèches ou aux sols nettement pauvres. Avec une pluviométrie moyenne ou élevée les rendements obtenus ont été très bons tant en petite saison qu'en grande saison. Voici quelques chiffres obtenus dans les essais comparatifs de variétés en 1939 : en vierges 64 tonnes à l'arpent à Britannia, 43 tonnes à Beau Champ, 40 tonnes à Savannah ; en repousses 64 tonnes à l'arpent à Union (Ducray), 53 tonnes à Rivière des Anguilles, et 40 tonnes aux Pamplemousses. En 1940 l'on récolta en vierges 52 tonnes à l'arpent à Pierrefonds et 44 tonnes à Bénarès tandis qu'en repousses l'on obtint entre autres rendements, 38 tonnes à l'arpent à Britannia, 46 tonnes à Savannah, et 45 tonnes à Beau Champ. Un établissement sucrier de Flacq dit avoir obtenu en grande culture plus de 70 tonnes à l'arpent.

En ce qui concerne la qualité du jus, la M. 171/30 possède quelques caractéristiques intéressantes. La période de croissance de cette variété pouvant être très longue sa maturation sera lente et son jus pauvre lorsque, comme en 1939, la saison sera favorable à une croissance tardive. Cependant dans les régions à pluviométrie élevée il semble que cette variété se compare plus favorablement aux autres variétés notamment dans les régions de " Sans Souci " et de " Riche Fond ". Ceci s'explique probablement par le fait qu'elle a achevé tôt la plus grande partie de sa croissance. Lorsque les conditions sont favorables à la maturation, la M. 171/30 donnera des richesses assez bonnes. C'est ainsi qu'en 1940 sa richesse fut très satisfaisante dans les essais comparatifs de variétés à Bénarès, Union Park, Deep River et Beau Champ. On se souviendra qu'au cours de cette année la pluviométrie après avoir été très élevée en Mai baissa rapidement et d'une manière uniforme causant ainsi une maturation régulière dès le début de la coupe.

La M. 72/31 est un produit de la P.O.J. 2878 et de la canne " noble " M. 35/17 et contient par le fait une faible proportion de sang sauvage. Elle s'est bien comportée sous les climats, très variés de l'île et semble s'adapter particulièrement aux régions froides à pluviométrie élevée La germination est très bonne et la croissance rapide. On s'est plaint parfois des duvets recouvrant les gaines des feuilles, mais d'après notre expérience cette variété ne diffère guère de la P.O.J. 2878 et ne cause aucun ennui aux planteurs habitués à cultiver cette dernière. Voici quelques chiffres parmi les résultats obtenus en 1939 : en vierges 56 tonnes à l'arpent à Britannia, 43 tonnes à Beau Champ et 36 tonnes à Savannah ; en repousses 47 tonnes à l'arpent à Rivière des Anguilles, 31 tonnes à Sans Souci et 33 tonnes aux Pamplemousses. En 1940 la M. 72/31 donna en vierges 58 tonnes à l'arpent à Pierrefonds et en repousses 34 tonnes à l'arpent à Britannia, 41 tonnes à Savannah et 37 tonnes à Beau Champ.

De toutes les variétés livrées jusqu'ici aux planteurs par la Station de Recherches sur la Canne à Sucre, la M. 72/31 est celle qui possède le meilleur jus. Elle a toujours donné une richesse excellente s'approchant de celle de la B.H. 10 (12) et parfois même la surpassant. Cette richesse élevée constitue une qualité importante car malgré que la M. 72/31 donne souvent des rendements inférieurs à ceux de la M. 171/30 et de la M. 134/32, son rendement en sucre à l'arpent est néanmoins très bon sauf dans les régions très sèches qui ne lui conviennent pas.

La M. 134/32 contient aussi une certaine proportion de sang " sauvage " héritée de la P.O.J. 2878. Ce " seedling " remarquable est très connu des planteurs à l'heure actuelle. Ses caractéristiques les plus importantes sont une bonne germination, un feuillage recouvrant rapidement le terrain et empêchant ainsi la pousse des mauvaises herbes, une apparence saine, et un gros rendement aux champs. Elle semble aussi résister très bien aux cyclones. Cette variété est devenue si populaire qu'on en plante sur une grande échelle dans toutes les localités de l'île et c'est pour cette raison que nous donnerons quelques indications au sujet de sa culture. D'après notre expérience la supériorité de la M. 134/32 est plus marquée dans les régions sèches du littoral, particulièrement dans le Nord, et dans les sols peu fertiles. C'est sous ces conditions que l'on peut tirer le plus d'avantages de sa rusticité. Dans les sols fertiles et là où la pluviométrie est élevée les rendements aux champs de la M. 134/32 ne sont guère meilleurs que ceux des deux autres variétés déjà mentionnées mais ils sont cependant supérieurs à ceux des anciennes variétés cultivées. Dans des conditions normales de culture la " grande saison " n'est pas recommandée pour cette variété : elle pousse si rapidement que tout en produisant de gros rendements les cannes se couchent facilement et dépassent le point de maturité optimum entraînant ainsi un abaissement de la richesse saccharine. Par contre, en " petite saison " ou en " moyenne saison " les rendements aux champs sont satisfaisants, les richesses bonnes et les souches repoussent avec vigueur. Lorsque la saison est favorable à la

floraison, la M. 134/32 peut être décevante surtout dans les champs plantés tôt. Ceci se produisit dans le district de Rivière Noire en 1940, mais il ne faut pas perdre de vue que d'une façon générale le nombre de flèches a été anormalement élevé cette année.

Quoique la M. 134/32 ait donné de très gros rendements dans plusieurs essais comparatifs de variétés, sa supériorité relative s'est affirmée d'une façon plus nette sous des conditions défavorables. Considérant la variété témoin comme égale à 100 dans chacun des cas, la M. 134/32 a donné en 1939 un indice de comparaison en vierges de 143 à Beau Séjour, 207 à Deep River, 162 à Savannah, et en repousses 156 aux Pamplemousses, 250 à Réduit et 155 à Saint André. En 1940 les indices correspondant furent en vierges 178 à Labourdonnais et 128 à Pierrefonds (dans d'autres essais elle fut utilisée comme témoin en comparaison avec de nouveaux " seedlings ") et en repousses 134 à Britannia, 114 à Beau Séjour, 189 à Savannah, 239 à Réduit, et 154 à Deep River.

La richesse de la M. 134/32 a été intermédiaire entre celle de la M. 72/31 et de la M. 171/30 et elle devrait être une très bonne canne à l'usine. C'est un fait bien connu que les variétés possédant du sang sauvage, telles que la P.O.J. 2878 par exemple, peuvent dans certains cas donner un jus qui offre quelque difficulté à l'usine. Quoique la M. 134/32 contienne une légère proportion de sang sauvage, il est réconfortant de constater que jusqu'ici la manipulation de cette canne n'a présenté aucune difficulté à l'usine.

Les demandes importantes de boutures ainsi que l'accroissement rapide des superficies plantées témoignent de la grande faveur dont jouissent la M. 171/30, M. 72/31 et M. 134/32 auprès de la communauté des planteurs. Tout porte à croire qu'elles occuperont dans un avenir prochain une grande proportion des terres cultivées en cannes à Maurice. Pour le moment la sélection de nouvelles variétés se poursuit, et les variétés selectionnées sont comparées à ces trois variétés sous les conditions les plus diverses. L'on comprendra aisément l'importance de ces essais car seules les variétés nettement supérieures parviendront à surpasser ces trois variétés. On ne peut espérer obtenir immédiatement une canne parfaite ; on doit se contenter de remplacer avantageusement les cannes existantes : tel est le but de tout travail d'amélioration de la canne.

HOW TO PRODUCE STEAM ECONOMICALLY, REDUCE TO A MINIMUM THE STEAM CONSUMPTION AND AVOID THE WASTING OF STEAM IN THE DIFFERENT DEPARTMENTS OF OUR SUGAR FACTORIES.*

To the memory of Sir Henri Leclezio K.C.M.G. and Captain H. G. Hitchcock O.B.E. to whom the author dedicated the original communications published in "La Revue Agricole" in May 1927 and September 1929 respectively.

L. J. COUTANCEAU, A.C.G.I. ; A.M.I.C,E. ; M.I.MECH. E.
Chartered Engineer — (Civil & Mechanical).

This communication is mainly intended for our local sugar factories. A 12½% fibre cane, a 24.5% bagasse in cane and a bagasse containing 51% fibre, 3 o/o sugar and 45 o/o moisture have been assumed in our calculations, same being the average obtainable in Mauritius. It can also apply to other factories in countries like India and South Africa where 15 o/o and 16 o/o fibre canes are encountered, and there, the surplus bagasse is utilized or could be utilized for the manufacture of cellulose, celotex boards, briquettes and paper.

In Mauritius however, for those factories manufacturing white sugar, the bagasse of a 12½ o/o fibre cane is barely sufficient and, where some of the departments of our factories are not properly installed, a certain amount of extra fuel, generally wood, has to be used, the amount of which could be greatly reduced if careful attention were given to those departments where steam economy could be realised. Although a great number of factories have for the last 15 years or so, done a great deal towards that aim in spite of the low market conditions, yet, there remain some which, presumably through insufficient capital, have not been in a position to do so, and, perhaps due to this, it is curious to note that although the number of sugar estates are not very numerous and the engineers advising those estates very few, no two factories are proportioned and installed on the same lines in their different departments for a maximum steam economy.

It is also a great pity that it has not been possible so far to instal in every factory a Lea Recorder in order to determine the quantity of water fed to the boilers per ton cane hour. By the installation of such a recor-

* Copyright of the Sugar Industry Reserve Fund.

der the Manager of the estate would have been in a position to check the steam economy made, each time a department of his factory had been altered in view of fuel saving. On the other hand, adjusting all the different departments for steam economy, the Engineer would have been able to determine the real steam consumption per ton cane hour for the manufacture of White or of Raw Sugar. Not having exact figures to work upon, the author thinks that he is on the safe side when assuming that the steam consumption per ton cane hour is 750 kilos for the manufacture of white sugar and 625 Kilos for that of raw sugar.

Reverting to the title of this communication, the sugar factory can be divided into three distinct departments :

1o. The first one where the steam is generated or the Boiler House Department.

2o. The second, where the steam is used to heat the juice to about 92 °C and to evaporate same to about ¼ of its volume, i e. the Heating and Evaporating Department. That department is the only one where it is possible to effect the greatest saving in steam. It comprises the Juice Heaters and Evaporators which must work conjointly if maximum steam economy is desired.

3o. The third, where only a comparatively small saving in steam consumption may be effected but where, if rightly proportioned, no wasting of steam will be experienced. This includes the Boiling House and Centrifugals Departments.

No consideration is taken concerning the different steam engines required in a sugar factory, these being considered as reducing valves, the steam exhausting from them being utilized for the evaporating and boiling stations.

In a factory with multitubular boilers, some 7 o/o amounting to 50 Kilos of steam per ton cane hour is lost through condensation in the steam piping and engines. This loss is greater when these boilers are overloaded and produce wet steam instead of dry saturated steam ; for the multitubular boilers cannot be easily fitted with superheaters as in water tube boilers the superheating avoiding or reducing condensation in steam pipes.

Care therefore must be taken not to overload the multitubular boilers of a sugar factory ; normally loaded boilers steam easily and generate dry saturated steam thus reducing to a minimum the loss due to condensation.

We will now consider the first department and show how the steam can be produced economically.

1o. The Boiler House Department

This department generally consists of Boilers, a Green or other Economiser and an Induced Draft Fan.

As previously stated, the boilers should never be overloaded, not only to prevent them producing wet steam which affect the real steam consumption of the factory, but chiefly because, when working at makers' rating, i.e. easy steaming one makes sure that one kilo of bagasse will evaporate the maximum quantity of water.

Working at makers' rating (no overload) the evaporation from and at 100 °C is 18 Kilos of water per square meter of heating surface per hour. Taking the heat absorption of a multitubular boiler as 9500 calories per square meter Heating surface per hour and the cœfficient of heat transmission of the boiler at 25 calories /m² heating surface/hour/1°C mean temperature difference, we have at makers' rating the mean temperature difference of the boiler $\Delta_B = \frac{9500}{25} = 380$ °C.

We also assume that the boilers are fitted with an ample combustion chamber designed so that the gases and air are well mixed and our preference goes to the double circulation flow mounting where less draught is required to draw the gases formed by the combustion of the bagasse thus ensuring that no unburnt particles of bagasse is blown over the chimney.

The Economiser generally met with in our factories is the one manufactured by Messrs. E. Green & Son Limited of Wakefield. Those manufacturers advise that in order to obtain the highest efficiency in their Economisers, the apparatus should empty itself once every hour and allow a heating surface of 0.0325 square meter for every Kilo of water or say 0.35 square foot per Kilo of water supplied to the Economiser. In Mauritius this capacity is never met with and the capacities found vary from 0.15 to 0.25 square foot for every kilo of water supplied. The capacity as advised by the manufacturers is very costly, but if boilers with no overload are worked in conjunction with such Economisers, one ton of our 12½% fibre cane would evaporate about 700 kilos of water per hour, the flue gas temperature after the economiser however would only be 130 °C. This temperature might be suitable however for the elements of a Green Economiser, but if a multititubular boiler type Economiser of equivalent capacity were use instead, this temperature might prove too low and corrosion due to the condensation of a pyroligneous acid would set in rapidly and diminish the life of such an Economiser.

The author in the calculations to follow has not taken the cœfficient of heat transmission of the Economiser according to the figures given in Hausbrand's experiments with a certain type of Economiser, this average cœfficient being 12.5 Calories per square meter of heating surface per hour per 1° C mean temperature difference. The figure adopted is 21 and is the average of the results of tests carried out with Green Economisers given in Kempe's Engineers' Book and also in Messrs. E. Green & Son's catalogue.

The fans used in Mauritius is the Musgrave Induced Draft Fan. This should be of ample capacity in order to maintain a draft of from ¾" to 1"

of water at the most in the main flue when the bagasse is sure to be burnt on the grates only and no unburnt particles blown over the chimney.

This fan should not be fitted with a Deadweight Mason Regulator as originally installed, but, with the modern Mason Compensation Weights Regulator thus eliminating jerky and spasmodic action. This modern regulator controls the speed of the steam-driven fan engine so as to furnish the right amount of draft for efficient combustion in accordance with the steam demand upon the boilers. The compensating device of the Regulator prevents full travel of the piston with each slight change in boiler pressure so that in service the valve maintains a floating position and regulates the speed of the engine without spasmodic action. In order to illustrate how to produce the steam economically from the bagasse of the 12½ o/o fibre cane, the author for that particular case* has drawn curves so that anybody can see by consulting those curves, how to alter this department for greatest efficiency.†

For the calculations the fundamental equations for Boilers and Economiser have been taken from the communication written by the Author in the " Revue Agricole " of September 1929 and are summarized below.

The CO_2 content of the flue gases has been taken at 12 o/o corresponding to an excess of air of 65 o/o for we all know that, this content is the safe limit for the bagasse to burn with a high degree of efficiency without the presence of CO. The calorific value of our dry bagasse C_B = 2435 Calories per Kilo at normal temperature and pressure.

The heat capacity of bagasse working with an excess of air of x times the theoretical amount required is given by the expression h = 1.0566 + 0.6594 x Calories per Kilo bagasse/1°C and therefore for the above 65 o/o excess of air h = 1.5 Calories/kilo bagasse/1°C.

The furnace temperature t_o is given by the expression

$$t_o = \frac{1809.64 + (h - 0.3513)\, t_a + 0.732\, t_b}{h}$$ in °C where

t_a and t_b the air and bagasse temperatures have been taken at 30 °C consequently t_o = 1250 °C.

The boiler pressure has been taken at 100 lbs. per square inch gauge the temperature of steam at that pressure or t_B = 170 °C and the total heat of steam at t_B = Q = 660 Calories. The mean temperature difference of boiler at normal rating i.e. no overload = Δ B = 380 °C. The initial feed water temperature θ_1 has been taken at 65 °C. If θ_2 = final feed water temperature entering boiler in °C then, in the boiler, Calories required per kilo of water = $(Q - \theta_2)$, and in the Economiser Calories required to heat one kilo of water = $(\theta_2 - \theta_1)$.

* Each case in any sugar factory should be worked out independently.

† The curves are annexed at the end of this number.

If t_1 = flue gas temperature after boiler i.e. before Economiser in °C

t_2 = do Economiser °C

H_B = heat absorbed by boiler in Calories and H_E by Economiser in Calories,

Then $H_B = h\ (t_0 - t_1)$ Calories and $H_E = h\ (t_1 - t_2)$ Calories and Heat absorbed by plant = $H_B + E = h\ (t_0 - t_2)$ Calories

E = Evaporation in Kilos of water/kilo of bagasse = $\dfrac{H_B}{Q - \theta_2}$

E_s = Evaporation in kilos of water/sq. ft. H. S/hour = $\dfrac{\Delta B \times K_B}{Q - \theta_2}$

S_B = Heating surface of boiler in square meter per kilo of water fed per hour.

K_B = Cœfficient of heat transmission of boiler
= 25 Calories/square meter heating surface/hour/1°C M.T.D.

ΔB = Mean temperature difference of boiler at any load in °C

S_E = Heating surface of Economiser in square meter per Kilo of water to be heated per hour.

K_E = Cœfficient of heat transmission of Economiser.
= 21 Calories/square meter heating surface/1°C M.T.D.

ΔE = Mean temperature of Economiser in °C for any value of t_1

Then :

$$\Delta B = \frac{t_0 - t_1}{\log e \cdot \dfrac{t_0 - t_B}{t_1 - t_B}} \text{ in °C.}$$

$$S_B = \frac{(Q - \theta_2)}{K_B \cdot \Delta B} \text{ in square meters.}$$

$$t_2 = \frac{\theta_1 (t_0 - t_1) + Q \cdot t_1 - \theta_2 t_0}{(Q - \theta_2)} \text{ in °C}$$

$$\Delta E = \frac{\left\{(t_1 - \theta_2) - (t_2 - \theta_1)\right\}}{\log e \cdot \dfrac{t_1 - \theta_2}{t_2 - \theta_1}} \text{ in °C}$$

$$S_E = \frac{(\theta_2 - \theta_1)}{K_E \cdot \Delta E} \text{ in square meters.}$$

Curves have been drawn for a plant with an Economiser and Boilers working at different overloads up to 40%. The feed water temperature entering the boiler or θ_2 has been taken as abscissa and as ordinates E, S_B, t_2, Δ E and S_E for those different overloads. The author will not comment on those curves for as already mentioned one glance at them will allow anybody to alter the boiler department so as to produce steam economically.

20. The Heating and Evaporating Departments.

If the steam consumption is to be a minimum, the heating and evaporating of the juice must not be performed separately. The only way to reach that aim is to feed the high velocity juice heaters by the vapour bled from the second and first vessels of a Quadruple Effect Evaporator, the juice to be brought up in that way to a temperature of 92 °C, the water evaporated in the juice being 75% by weight.

For those estates manufacturing white sugar and burning extra fuel in spite of all the different departments being arranged for a minimum consumption of steam, a pre-evaporator can be considered to make up for the deficiency.

Although most of our factories have for the last fifteen years altered their evaporators by feeding heaters with vapour bled from the first or second effects or both, some utilising their open heaters, some using the modern high velocity heaters, yet there are not many whose juices reach 92 °C before flowing into the defecators the final temperature varying between 70 °C and 85 °C. The reason for that low temperature experienced is that the existing evaporators were either originally not designed for that purpose or have been overloaded since the manufacture of Raw Sugar in the Colony which allowed the increase of tonnage crushed per hour.

We must all strive to have the juice heated to 92 °C before reaching the defecators for juices at temperatures varying from 70° to 85°C, when heated to " cracking " temperature in the defecators, require more steam due to their inefficient heating surface and head of juice over that heating surface, than would be the case if they were heated in proper heaters for the same rise in temperature.

There are still factories working with Triple Effect Evaporators, some of them well designed for the heating of the juice and not burning extra fuel when manufacturing raw sugar. It is regretful however to record that during the last crop a few factories were still working with straight Triples especially those manufacturing white sugar and hence burning extra fuel ; the juice in those factories being heated in inefficient open heaters to a relatively low temperature require more heat in the defecators thus increasing the steam consumption.

As mentioned before, the author, thinks it is only through lack of capital that it has not been possible to alter all the deparments of those factories, the owners having to attend to more urgent needs. However it would certainly have been a great benefit for those factories to alter that

department where the greatest saving in steam consumption can be obtained, the saving in the cost of extra fuel would have compensated the cost of installation.

In order to prove what has just been said let us consider the treatment of 1,000 Kilos of diluted juice per hour (this representing roughly the juice of one ton of cane per hour with some 30/33% dilution).

1o. *When juice is heated and evaporated independently.*

To heat 1,000 Kilos of juice per hour from 28° to 92°C would require 110 kilos of steam.

To evaporate 75% by weight of that juice would require :—

(a) In a straght Triple Effect about 300 kilos of steam/hour.

(b) In a straight Quadruple Effect about 240 kilos of steam/hour.

The steam consumption per hour would then be :—

(a) In a factory with a straight Triple Effect about 410 kos.

(b) In a factory with a straight Quadruple Effect about 350 kilos.

Thus a saving of 60 Kilos of steam per 1,000 Kilos juice per hour by substituting a Quadruple to a Triple.

2o. *When the Juice is heated by vapour bled from the Evaporator* :—

The heater on the second vessel would heat the juice from 28°C to 73°C and that on the first vessel from 73°C to 92°C and the Evaporator would evaporate 75% by weight of the juice.

The steam consumption per hour for heating and evaporating would then be :—

(a) In a factory with Triple Effect feeding heaters about 350 kilos

(b) In a factory with Quadruple Effect feeding heaters about 300 kilos.

For those few factories which still have straight Triples and the heating of the juice done independently, it will be easy for them, according to their financial situation, to decide how to alter that department.

To save the same amount of steam per hour viz. 60 Kilos, the factory which has a straight Triple will have either to alter his Triple into a Quadruple or to instal heaters and work them from vapour bled from the second and first Effects.

The first move would then be to instal the heaters, as only two-thirds of the heating surface in heaters would be required instead of that necessary in the additional vessel to alter the Triple into a Quadruple. Besides one square foot of heating surface in a heater costs less than one square foot in the complete vessel of an evaporator.

If by this alteration and the saving of steam, no extra fuel is burnt in the factory, the aim has been reached, and the installation is bound to pay for itself.

If, on the contrary, when manufacturing white sugar, there has been only a marked reduction in the cost of extra fuel, and more steam economy is required, then the Triple can be altered into a Quadruple (the same heaters would be utilized on the second and first Effects) and a further saving of 50 kilos of steam per hour would be effected.

As one can see, for a factory crushing 50 tons cane per hour, in the first installation there is saving of 3 tons of steam per hour representing about 860 kilos of wood per hour.

In the second installation the economy is a further 2,500 kilos of steam per hour representing about 720 kilos of wood.

If both installations could be made at the same time, over 1½ tons of wood as extra fuel would be saved per hour ; it would be interesting if such installation were made, to check the economy by a Lea Recorder.

Another point I would like to lay stress upon is the following :—

To raise the temperature of the juice by vapour bled from the second and first Effects of an evaporator from 28°C to 92°C in a well designed evaporator requires two heaters of the same capacity.

If, the owner of the factory cannot afford in one year the two heaters but only one of them, the only way to instal that heater is on the second effect and not on the first one. This is obvious, for by so doing, the heater although requiring about the same quantity of vapour to heat the juice in both cases, will, when placed on the second effect, cause an equal quantity of vapour to be evaporated in the first effect. In other words, by so doing, twice the quantity of vapour will be evaporated.

3o. The Boiling House and Centrifugals Department.

Unlike the Evaporator which is a continuous apparatus, the Pans are intermittent and care should be taken in designing that department to have sufficient heating surface and massecuite conveyor capacity to allow the pans to discharge their strike quickly in that conveyor and start again within 20 minutes in order that steam should never be blown over the factory and thus wasted. For this purpose, the required Pan capacity, working on the safe side, can be taken as three tons of massecuite per ton cane hour and should be distributed in some five Pans, preferably six The heating surface of the pans should be from 45/55 square feet per ton of massecuite and preference should go to Calandria Pans working at low steam pressure, as these can utilize the whole of their heating surfaces during concentration of the clairce ; however for the last massecuite preference should go to Coil pans. By adopting the above proportions, it is possible to effect an automatic steam distribution in the Evaporator and Pans departments so that the men in charge of those apparatus should never interfere with the steam distribution. This however can only be achieved if the Evaporator and Pans are designed in such a way that the Evaporator will always work with a steam pressure of a few pounds in excess of what is required to work the Pans.

The whole of the exhaust steam of the factory should then be directed to the Evaporator Exhaust Steam Receiver which is also connected to the Pans receiver by means of a pipe and balanced valve actuated by a Mason Regulator. This Regulator maintains a fixed steam pressure of say 5 pounds per square inch in the Evaporator Receiver. The Evaporator at that pressure takes the quantity of steam required for its good working, the balance going to the Pans Receiver regulated say at 4 pounds per square inch, by means of a safety valve. This balance of steam however is not sufficient for the working of all the Pans when two are concentrating at the same time, and live steam has to be fed to the Receiver in order to maintain the working pressure of the Pans at 3 pounds per square inch. This should then be performed by a second Mason Regulator which shuts off the steam supply as soon as it is no more required (i.e. after concentration) and the pressure tends to rise above three pounds per square inch. By so doing the steam distribution in those two departments is automatic, no steam wasted or blown over the factory if the heating surfaces of the Pans are properly designed.

The centrifugal department should have the required screen capacity and 30", 36" and 40" machines should be the size chosen as the thickness of layer of massecuite to be centrifuged is not excessive in those centrifugals as compared with the 42" and 48" machines, a thinlayer is better when dealing with massecuites prepared from refractory juices.

The difficulty in centrifuging massecuites from the refractory juices seems to have been overcome by the new D'Hotman-Berenger process which has been applied at " Highlands " during the last crushing season; it was observed there, with that new process that the Pans completed their duty some time before the mills had performed theirs whilst the centrifugals took only some 10½ to 11 hours to cure the sugar produced in 24 hours (time taken formerly being some 21 hours) thus effecting a saving in steam in that department. It is not possible for us to give the exact figures of the economy of steam achieved, but Messrs. D'Hotman and Bérenger will soon be in a position to do so when they will describe their process in a communication which they are preparing for publication.

The above, we think, are the main considerations to be taken into account if an efficient working of the factory is contemplated.

The arrangement of the Heating and Evaporating station should be considered first, that station being the only one in which the greatest steam saving (about four times that effected in the Boiler Department) is obtainable especially for those factories burning extra fuel.

With reference to the Boiler Department, the curves have been drawn *for a* 12½% *fibre cane* and they show how to get the most out of the fuel therefrom, and, we hope that every factory manager or chemist will in future study his own particular case (fibre content etc., excess of air and boiler pressure) and alter this department accordingly.

The owners, should on their own part, realise how indispensable it is

to instal in their factories a Lea Recorder in order not only to control the steam consumption but to allow those in charge to detect and alter the faulty departments. This apparatus is not costly, and will allow of a more scientific working in the factory giving a great help towards standardising the general arrangement of our sugar factories for the great variety of canes they have to crush.

Before concluding, the author would like to draw the attention of all concerned to the following remarks :—

Knowing the elasticity of some of the machinery utilised in the manufacture of sugar, we all have a tendency to overload those plants, especially when our financial position does not allow us to order the machinery necessary to attain the required capacity.

The two plants which can stand the most overloads are the Boilers and the Air Pumps.

Boilers : By overloading the boilers we increase the fuel consumption and may be compelled to use extra fuel ; moreover, through necessary heavy firing the life of the boilers is diminished.

Air Pumps : When these pumps are overloaded the vacuum is necessarily decreased, necessitating an increase of pressure in the steam receivers feeding the Evaporators and Pans in order to ensure the temperature difference necessary for their proper working.

We must not overlook the fact that increasing the pressure in the steam receivers is increasing the back pressure of the steam engines of the factory with all its drawbacks.

We had always overloaded our machinery, but since manufacturing raw sugar, we have a greater tendency to do so in order to crush more canes hourly, knowing that the juice to produce such sugar is alkaline, hence the evaporators and pans work practically with clean heating surfaces and do much more work than when evaporating the acid juice for the production of white sugar.

We know of a great number of evaporators doing some 25% more work with raw sugar as compared with the same installation producing white sugar, when scaling due to sulphites is intense.

We do not know if we may not be called upon to produce white sugar ; such a contingency will be a great hardship for a fair number of our factories. Considering the increase of production of canes in the Colony, the factories are no more proportioned for white sugar production. Moreover, manufacturing sugar with the sulphitation process brings a greater wear and tear, and the replacement of machinery in the present condtions is becoming more and more difficult.

Even if we were not called upon to manufacture white sugar, it would be wise for all concerned to give up the old idea of overloading machinery and to aim at proportioning their factories for a 90 *days crop white sugar manufacture.* Should they, after so doing, continue to produce raw sugar, they will have the advantage of possessing factories which will be capable of dealing with the crop in 70 days, starting crushing later when the canes are more matured thus reducing their cost of production.

MÉTHODES DE CALCUL RAPIDE POUR LES CHIMISTES DE SUCRERIE.

A l'intention de nos collègues qui, pendant la coupe, ont le lundi de longs et fatigants calculs a faire en vue d'établir les moyennes proportionnelles nécessaires au bulletin hebdomadaire nous traduisons du " Laboratory Manual for Queensland Sugar Mills " et copions du " Vade-mecum de Sucrerie " de Pillet et Métillon, respectivement les deux méthodes de calcul rapide suivantes. Elles sont, comme on peut le voir, à peu près identiques :

1o *Méthode rapide pour le Calcul des moyennes proportionnelles des chiffres " pendant la semaine " et " antérieurement " dans le bulletin de contrôle chimique de sucrerie.*

En rédigeant son rapport hebdomadaire le chimiste doit donner les chiffres " A ce jour " de chaque item, ce qui prend un temps considérable et nécessite un travail important, par la méthode arithmétique ordinaire. La méthode suivante est simple et rapide, et, intéressera probablement les chimistes qui ne la connaissent pas.

Le chiffre " Antérieurement " (cannes, mélasse ou sucre) est divisé par le nouveau total produisant un facteur. La valeur de chaque item de la nouvelle période est alors soustraite de la moyenne antérieure, et la différence obtenue est multipliée par le facteur. Le chiffre ainsi obtenu est ajouté à la nouvelle valeur et donne la nouvelle moyenne. Si le chiffre de n'importe quel item est plus élevé dans la nouvelle période que dans celle précédente, la différence sera *négative* et devra être soustraite. Ceci est illustré par l'example suivant :

	Tonnes cannes	Cannes	
		Ligneux %	Pol. %
Antérieurement	172.108	13.42	16.81
Semaine	18.307	14.08	15.75
A ce jour	190.415	13.48	16.71
Facteur $= \frac{172.108}{190.415} = 0.9039$			

Calcul du ligneux		Calcul de la Pol.
13.42 — 14.08 = —0.66	—	16.81 — 15 75 = 1.06
—0.66 × 0.9039 = —0.60	—	—1.06 × 0.9039 = 0.96
14.08 + (—0.60) = 13.48	—	15.75 + 0.96 = 16.71

Evidemment cette méthode ne s'applique pas aux moyennes des valeurs calculées telles que : dilution, tonnes de cannes à l'heure, pourcentage de temps perdu etc ; celles-ci doivent être trouvées par les moyens ordinaires.

2o En appelant :

	Antérieurement	—	Pendant la semaine	—	à ce jour
Quantités de betteraves travaillées :	A	—	B	—	A+B
Richesse de la betterave o/o kgs :	a	—	b	—	x

la richesse proportionelle à ce jour sera :

$$x = a + \frac{b - a}{1 + \frac{A}{B}}$$

ce calcul s'applique à toutes les moyennes proportionnelles et permet d'en effectuer rapidement toute une série ; il suffit en effet de calculer une seule fois le rapport $\frac{A}{B}$ qui est fixe et que l'on applique à toutes les moyennes à faire pour la semaine.

A. MARTIN

HOSTS OF THE SUGAR CANE GUMMING DISEASE ORGANISM

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Introduction.

The Gumming disease caused by *Bacterium vasculorum* (Cobb) Greig Smith, one of the major sugar cane diseases, was first reported from Brazil in 1869. Inasmuch as the sugar cane is not a native of Brazil, the disease is believed to have been passed on to the plant from some tall South American grass (2), but up to recently, no natural host of the pathogen other than the sugar cane was known.

From Brazil, it is believed to have been carried to Mauritius in 1869, and to have been subsequently responsible for the failure in the island of many of the best sugar cane varieties of the past.

The disease probably reached Australia and Fiji from Mauritius, becoming there rapidly disseminated and resulting in a first series of epidemics towards the close of the nineteenth century. North (7) states that the disease was gradually brought under control in each district chiefly by the replacement of the susceptible varieties by more resistant ones, and that it finally became extinct in most of them. Thus it is that in Fiji no case of the disease has been recorded since 1913.

In Australia, however, the extinction of the disease was perhaps more virtual than real, and from 1920 to as late as 1934 (Hughes, 4) sporadic

outbreaks of varying importance occurred in various districts on susceptible varieties which had been planted meanwhile. It is supposed that a reintroduction of the disease in the new varieties planted occurred in some cases and that others were possibly due to the persistence of local focci of infection. Anyhow, the new epidemics were also brought under control by the systematic planting of resistant varieties.

North does not think that host plants other than the sugar cane may have been responsible for the recurrence of the disease, for he states (7) that its peculiar liability to become extinct after having been brought under control indicates that there are no other host plants in Australia or Fiji which assist in its survival. North adds that :

" complete eradication of gumming from Australia is now confidently anticipated ".

Hughes, however, says that it must be admitted (4) that the specific factors controlling the complete disappearance of the disease are not known, and states that necessity exists :

" for caution in planning a return to susceptible varieties in a once infected locality. "

As regards Mauritius, although it is quite possible for the gumming disease to have been introduced more than once, there is no record that it became extinct at any time. North (7) expresses the opinion that :

" the prevalence of gumming for so many years in Mauritius and the absence of any tendency for it to become extinct as it has done elsewhere, is evidently attributable to several of their (*our*) so called " resistant " varieties being of the susceptible but tolerant type and serving as carriers."

This is perhaps only part of the truth.

It was said above that up to recently no natural host of the pathogen other than sugar cane was known ; in the pages which follow the writer will put forward proof that a maize disease studied by him in 1932 and of which authentic record exists (17) was caused by *Bacterium vasculorum* ; he must therefore claim priority not only for the discovery of the existence of this natural host of the organism, but also for having through his inoculation work then carried out, infected maize artificially for the first time with the organism, although the identity of that organism was not then known to him. Besides maize, the writer in 1937 discovered two other natural hosts of the organism in the island, namely : palms of the genus *Dictyosperma*, and the indian tiger grass *Thysanolæna agrostis* Nees (11,12,13,14).

These discoveries have changed the outlook about the future of our campaign against the disease, as aimed at previously, that is, first its complete control, then its extinction, by the systematic cultivation of solely resistant varieties. Such an achievement would have permitted the resuming later of the cultivation of susceptible varieties of cane which could possess

qualities superior to those of the resistant varieties which would have been employed to bring about the eradication of the disease.

Hughes, writing in 1938 (3), states that :

" few authors have considered the possibilities of the existence of *B. vasculorum* in hosts other than cane and none have discussed the possible importance of alternate hosts in the eradication of gumming from the cane crops of any particular area. "

This importance did not escape early attention in Mauritius and was brought out in 1938 in communications of which evidently Hughes could have then had no knowledge. (8, 15).

Had the discovery of the existence of these natural hosts not been made, a possible return in the future to the widespread cultivation of susceptible cane varieties by our planters would have resulted in fresh and perhaps costly epidemics.

It is true that the occurrence of the disease on maize is exceedingly rare in the island, the flint varieties now under general cultivation being apparently very highly resistant to infection in the field; but other varieties which may be cultivated in the future might not possess resistance to the same degree. Furthermore, except for one centre each, in the case of palm and of Thysanolæna, where for unknown reasons the disease occurs nearly in epidemic form, it is but occasionally encountered on these two plants It could be argued then that the destruction of diseased host plants other than the sugar cane, could be legally enforced and that such a step, coupled with the cultivation solely of resistant varieties of cane, would bring about the eradication of the disease from the island.

In the writer's opinion, it is highly improbable that the procedure would be a success, as it would mean having to eradicate the disease at the same time from several plants with widely different habits, some of which are often growing wild. Any diseased stray plant left would constitute a focus of dissemination even more dangerous than a new introduction of the disease ; for in the latter case, the disease could be controlled in its early stages, whereas in the former, its first spread would run unobserved. Furthermore, it is not known whether or not palms belonging to genera other than Dictyosperma may not harbour the disease in some mild form.

If the complete eradication of gumming from the island is thus probably impossible, we must however still aim at controlling it by the production and cultivation solely of resistant cane varieties, as this constitutes the only means of reducing our losses from that score. A heavier burden thus perhaps befalls our Sugarcane Research Station than is the share of similar breeding stations in other parts of the world ; for whereas it could be possible for these latter, after the gumming disease has been eradicated from the localities under their control, to accept for general

cultivation any good cane variety produced, irrespective of its behaviour to the disease, with us, it will be possible to release for general planting only such canes as will be highly resistant to the disease.

Acknowledgement :

The writer takes the present opportunity for tendering his thanks to Mr. S. F. Ashby, late Director of the Imperial Mycological Institute at Kew, for confirmation of the identifications arrived at and for advice and suggestions during the course of the experiments ; to Mr. E. F. S. Shepherd, now Plant Pathologist, Gold Coast, for helpful criticisms during the early part of the investigations ; to Mr. P. O. Wiehe, Plant Pathologist of the Department, for certain suggestions during the researches on some of the artificial hosts found ; to Mr. J. Duhamel, Plant Inspector, for his untiring assistance during the later and more extensive part of the researches ; and to Mr. C. A. O'Connor, Senior Agricultural Officer, for supplying palm plants whenever required for inoculation.

Part I — The Natural Hosts of *B. vasculorum* in the island.

1 — Maize.

Discovery of the disease and description of the symptoms.

On the 30th of March 1932, the writer detected in a young virgin cane field at the Central Experiment Station at Réduit, a maize plant showing long, white stripes on its leaves. The maize had been planted as trap-plant for borers.

The stripes followed the direction of the veins and, in most cases, extended though the whole length of the leaf. The width of the individual stripes varied from that of only one vein to about 3/16 of an inch, the margins being diffuse and yellowish in colour ; in the former case, lateral diffusion occurred at places along the affected vein, resulting in the production of narrow patches of yellowish-green tissue and forming a discontinuous stripe along the vein. The central tissue of the wider stripes dried out to brown, becoming thin and papery in texture.

Necrosed areas were seen in the pith, and at certain nodes brown fibres were present. One internode towards the bottom of the plant showed a large internal cavity, and light brown lesions were observed externally on the rind of some of the internodes.

Isolation of the pathogen.

On 31 3.32, a portion of the white stripe leaf tissue was crushed in mortar with a little sterile water and filtered through paper. The filtrate was used to inoculate five young maize plants into the stem by means of a hypodermic syringe.

From 5.4. to 16.5 32, four of the inoculated plants showed the characteristic white stripes on the leaves and two of them, which had started to dry out towards the top, were used for further work.

On 13.5.32, one of the dying plants was split open in the laboratory, when longitudinal pockets of yellow gum in the internodes were noticed for the first time. The gum was aseptically removed and cultures made. The following inoculations were also carried out :—

(a) injecting with the hypodermic syringe a suspension in sterile water of the aseptically removed gum into the stems of eight young maize plants.

(b) placing a drop of the suspension at the tip of the youngest leaf of the spindle of four plants.

(c) pouring into six plants eight to ten drops of the suspension inside the funnel of young leaves.

On 18.5. and 19.5.32, five of the (a) plants started to show well-defined white stripes on the leaves, and the spindle of two others was seen rotting ; these two plants died out subsequently. One plant showed no signs of disease. Infection was also not picked up by the (b) and (c) plants.

On 17.5.32, the second dying plant out of those inoculated on 31.3.32 was cut into sections through the internodes ; after a while, a copious exudation of gum was produced from the severed bundles. An ear had been produced by that plant and the ear stalk showed small water-soaked lesions internally and secreted drops of transparent gum from the cut vascular bundles. A yellow gum ooze was also noticed towards the bottom of the inner surface of the ear sheaths, produced from water-soaked lesions visible from the outer surface.

Dilution cultures were made of the gum ooze from the cut stem, scraped with a sterile knife, and on 23.5.32, two yellow colonies were fished and transferred to slants of peptone saccharose agar (Wilbrink's medium).

Proof of pathogenicity.

On 1.6 32 both cultures were inoculated into the stems of eight young maize plants, some by means of a hypodermic syringe and others by

needle stabs. Six other plants were used as controls, of which two were injected with liquid Wilbrink medium, two stabbed with a sterile needle and two kept untreated.

The plants remained unobserved for a while, but on 13.6.32, two of the plants infected by needle stabs with one of the cultures were showing long white streaks along some veins of the young leaves. By 30.6 32, the eight inoculated plants had shown both the linear, yellowish, and the wide white stripes, not only on the punctured leaves, but also on the later ones produced. On the last mentioned date, two of the inoculated plants were cut and yellow gum oozed from their severed bundles. All the controls remained healthy, save for the production of faint chlorotic bands from the punctures in some cases.

A transfer dated 11.7.32 of one of the pure cultures obtained on 23.5.32, and which, as shown above, had been proved pathogenic to maize, was forwarded for identification to the Imperial Mycological Institute on July 20th, 1932. The reactions and characters of the organism as determined at Kew are given in Part III of the present paper.

The organism sent to Washington.

Mr. S. F. Ashby sent cultures of the bacterium to Dr. Charlotte Elliott in Washington, who was then studying Stewart's disease of maize caused by *Aplanobacter stewarti*, asking her to let him known if it was like any pathogen known to her on maize.

In September 1933, the writer had official information that his bacterium had been found to be non-pathogenic to maize in America. His original cultures had unfortunately died out, and as the disease had not again been observed, no further work on the subject was possible. This was indeed not necessary, for E. F. S. Shepherd (17) recorded in 1932 the successful inoculations on maize in the following terms :

> " A bacterial disease of this plant, marked by a white striping of the leaves and the exudation of gum from the stem was discovered and investigated by the Scientific Assistant. A bacterium which proved pathogenic was isolated. "

A description of the experiments made and notes on the observations recorded were therefore forwarded to the Imperial Mycological Institute on 2.9.33.

Possible reasons for the failure at Washington.

The disease on maize has not been met with in Mauritius since, and the case observed in 1932 thus appears to have been an accidental attack by the pathogen isolated, perhaps owing to the varieties in general cultivation in the island being resistant to natural infection by the disease. A difference in the susceptibility of different varieties of maize to natural

infection by *Bacterium vasculorum* has been proved to exist in Queensland (Bell 1), and as Mr S. F. Ashby pointed out in a letter dated 1st December 1933,

> " it may be that the varieties susceptible to *Aplanobacter stewarti* which were inoculated at Washington were resistant to the Mauritius organism. "

In view, however, of the fact that the maize varieties (flint corn) in common cultivation in the island easily contract infection when the stem or the spindle is artificially inoculated with *B. vasculorum*, the writer suggested (13) that the failure to procure infection at Washington could have come through the inoculations having possibly been effected on fully opened blades. Such inoculations have been rarely successful with the author in the case of maize.

It is interesting to recall here that Hughes (4) reports having experienced similar difficulty in obtaining infection following leaf inoculation of maize with *B. vasculorum*. There is thus one important difference between sugar cane and maize as regards infection by *B. vasculorum*, for whereas sugar cane easily contracts infection through the leaf, maize apparently but seldom does so, and this explains the high resistance which maize shows to the disease in the fields.

At the writer's request, Mr Ashby enquired from Dr. Elliott on March 29, 1939, about the method she employed when she tested the pathogenicity of the Mauritius maize organism. In her reply, Dr. Elliott stated that

> " the inoculations on corn were made by scratching a leaf blade to injure the bundles and then applying the culture, and also by inserting the culture into needle punctures at the base of the stem. "

The first method, as just stated, is utterly unreliable. As for the second, it has been nearly 100% effective with the writer, when young plants in the " rosette stage ", i.e. before the internodes have elongated, are inoculated. It is then the pseudo-stem, i.e. to say, really the spindle, which is inoculated. If maize plants are inoculated into the bottom internodes after these have more or less fully elongated, no external signs of the disease may be exhibited. This is in accord with the findings of Hughes (4), who states that when maize plants approximately nine weeks old, with from six inches to two feet of stalk visible, were inoculated into the solid stem approximately ten centimetres below the growing point, or into the base of young cob shanks, absolutely no external pathological symptoms appeared at any time. However, when the sticks were cut and sweated at maturity, some sixteen weeks after inoculation, several oozed gum. The failure of the experiments at Washington would therefore be explainable if tall plants were used for the inoculations and if the appearance of external symptoms was looked for as the sole criterion for infection having been picked up.

Correspondence with the Imperial Mycological Institute.

The following other extracts of correspondence on the subject from Mr. S. F. Ashby, are given because, as was said above, the disease of maize has not again been noticed in the island.

Letter dated 16th April 1937. " On looking back at the correspondence of 1932 about the bacterium from maize, I think it very probable indeed that it was the same bacterium as the one from the palm. It is very interesting as being a natural infection of maize. "

Letter dated 15th September 1937. " The cultural characters as far as they went of the isolation from naturally infected maize were those of *B. vasculorum.* "

Reference should be made to Part III of the present paper, where further extracts of correspondence on the subject are given.

Inoculations of maize with B. vasculorum.

In march, 1937, the author learned of the discovery made in Queensland (1) that certain varieties of maize could be naturally infected by *B. vasculorum*. This recalled to his mind his observations on the disease of maize and also resulted indirectly in the identification of the pathogen of the palm disease.

Different cultures of *B. vasculorum* from sugar cane were then obtained and a series of inoculations on maize were made. The inoculations were successful. The symptoms observed on the inoculated plants agreed in their general lines with those given by Ivanoff (5). White bands (Pl. II, phot. 10) and linear stripes along the veins of the leaves developed in from 4 to 9 days after the inoculations. The discoloration of the veins often occurred at varying distances from the punctures, and were sometimes broken along individual veins by varying lengths of normal tissue. With certain isolations, numerous rather small necrotic spots occurred early in the chlorotic stripes, which dried out after a while. Some of the plants died as a result of the inoculations, and all showed gum exudation from the severed bundles when the stem was cut. Brown water-soaked lesions in the pith and cavities in the internodes were also present ; these cavities were sometimes of large size, running longitudinally through several internodes (Pl. II, phot. 12).

The bacterium was reisolated from the maize stripes and the reisolates were inoculated into healthy sugar cane leaves by the method described by North (7). Typical gumming stripes developed from the punctures in about twenty days. The variety of cane used in this and in all similar experiments mentioned in this paper was M. 55/1182, a variety very susceptible to leaf infection. Controls made by stabbing many times though a drop of sterile water placed on one side of the inoculated leaf, invariably remained healthy.

Conclusion.

The author hopes that the results of the investigations described above and of the laboratory study carried on at Kew, together with the authoritative opinion of the Director of the Imperial Mycological Institute, will be accepted as evidence amounting to definite scientific proof that the Mauritius maize disease studied in 1932 was caused by *Bacterium vasculorum* (Cobb) Gr. Sm.

2. — The Dictyosperma palm.

Discovery of the disease.

On October 8,1934, Mr. E. F. S. Shepherd (18) then acting Director of the Department of Agriculture, submitted to the writer diseased specimens of " palmiste blanc ". *Dictyosperma album* Wendl. & Drude, from Granravien estate in Flacq district. The disease was found to be of bacterial origin and, in 1937, was proved to be caused by *Bacterium vasculorum* (Cobb) G. Smith (11,13,14).

Symptoms.

On young plants, the disease is characterized by a rotting of the central spindle, followed by a slow death of the whole plant (Pl. I, phot. 1). The young leaves often show a bitten-leaf aspect (Pl. I, phot. 2), like that caused by the fungus *Ceratostomella paradoxa* (de Seynes) Dade, on the coconut palm.

Plants are sometimes seen with a certain number of old or semi-mature leaves showing the bitten-leaf aspect, whilst the remainder of the crown appears perfectly healthy. Such cases may represent either plants which at one time suffered from the disease but succeeded in throwing it off, or plants which were attacked by the *Ceratostomella* fungus itself. Indeed, although the writer has not found the fungus in association with the affected tissues of the " bitten " palm leaves, yet he has occasionally encountered it in the stems of dying young plants, and it may therefore perhaps sometimes cause on the Dictyosperma palm a disease similar to the one it brings about on the coconut palm (10).

Taller plants when affected by the disease may show from a few to many more or less partially blighted leaflets on otherwise apparently healthy leaves in all stages of growth, from old mature ones *to leaves just unfolding from the central spindle.* The blighted tissues vary (16) from Madder Brown to Liver Brown and Diamine Brown ; from the affected regions, a diffuse Olive Green to Pyrite Yellow discoloration extends over a greater or lesser area of the leaflet, definite yellow stripes being sometimes present towards the base of the blighted regions (Pl. I, phot. 2).

In the yellow portions of the leaflets, the veins show by transmitted light excessively fine, short, red streaks along their length. The course of the bundles may sometimes also be marked at intervals in these regions by small, semi-circular, purple-red dots (Pl. I, phot. 4). The spots which are characteristically semi-circular, always show a very narrow light yellow border.

Another appearance which is sometimes observed in the vicinity of the blighted portions of the leaflets is the presence of rather short, linear, pale-yellow streaks along a vein, visible only by transmitted light. (Pl. I, phot. 4).

In advanced cases of the disease, the leaflets still enclosed within the spindle may show long, thin to rather thick, red vascular bundles bordered on each side by a narrow band of yellowish tissue. If such leaflets succeed in opening out into the air before the death of the plant, the reddened bundles finally lie in the middle of a rather broad pale-yellow stripe which stands in strong contrast with the green leaf tissue on both sides (Pl. I, phot. 5).

The presence of the causative bacterium in the stripes above described has been proved by cultural work and by a very simple and convenient test used by the writer throughout his experiments with the hosts described in the present paper. The test is carried out as follows: A small portion of striped leaf tissue is placed in a drop of water on a microscope slide and covered with a cover slip After a few minutes, a very distinct milkiness will be seen at the cut ends of the vascular bundles, if the organism is present. If a microscope is used for the examination, the bacterial mass oozing from the infected bundle is noticed as soon as the preparation is made. The test is not specific for *Bacterium vasculorum*, but it is most useful for the rapid indication of the presence or absence of bacteria in the bundles examined.

On dissecting out the spindle of a badly diseased plant, brownish-black streaks corresponding to infected vessels, and sunken spots of irregular size and shape are seen on the inner surface of the sheaths of the innermost leaves. The spots may occur in rows along the infected bundles, and appear at first as narrow, elliptical, water-soaked lesions, which develop into light-brown sunken patches with irregular margin, and marked by transverse lenticular cuts at intervals. They arise from the easy spreading of the bacteria from an infected bundle into the soft parenchyma tissue towards the base of young leaf sheaths. The spots of the sheaths are often seen covered by a gummy exudate; they gradually become black in colour and assume a charred aspect. The wings of the sheaths may rot more or less completely; they often show the lesions known as " knife-cuts ".

On cutting transversely the stem of a wilting plant, or either the

rachis of the leaves or the midribs of affected leaflets, yellow to brown fibres are noticed, from which drops of yellow gum slowly ooze (Pl. I, phot. 6). Cases have been seen where healthy plants, or plants showing indefinite chlorotic stripes on the leaves, exuded drops of *clear* liquid from cut bundles; this condition, which has not been investigated, is easily distinguished from the disease caused by *B. vasculorum*, in that the ooze is here fluid at first, not gummy or sticky as in the bacterial disease; it becomes mucilaginous and finally dries out to small, transparent globules in the air.

The stem of a badly diseased plant may also show yellowish to brown patches of decaying tissue, or pockets in which the tissues have rotted completely. From such diseased stems, the fungus *Ceratostomella paradoxa* (de Seynes) Dade has at times been isolated, as mentioned previously.

Photomicrographs of sections of a diseased stem and of a blighted leaf are shown in Pl. V, phot. 29 and Pl. VI, phot. 31 respectively. In sections of tender stem tissues of severely diseased plants, the bacteria are often seen to have brought about the disorganization of the xylem elements where they are typically located, and to have invaded the surrounding tissues, extending as bacterial pockets into the adjoining parenchyma.

Mode of spread of the disease and its progress on an infected plant.

Although leaf stripes are a characteristic feature of the gumming disease of palm as of that of the sugar cane, a fundamental difference appears to exist in their mode of origin in the two plants. In the case of the sugar cane, the stripes are produced in two ways: firstly by secondary and secondly by primary infection of the leaves. In the first method which results in the more common and conspicuous symptom of the disease, the bacterium reaches the cane plant in wind-driven rain splashed from wetted leaves of a diseased plant, and penetrates the tissues of the healthy plant through wounds in the leaf surface made by the short, sharp teeth at the leaf edges (7). An incubation period follows, which the writer has found to vary from as little as 5 days in hot weather to about a fortnight generally, or even more in cold weather, when the characteristic gumming stripe is produced, one from each centre of infection. In the case of susceptible varieties of cane, the bacterium rapidly passes from the leaf, down the sheath into the stem, bringing about what has been called the "systemic" infection of the plant. It follows that the characteristic gumming stripes are never found on the young leaves unfolding from the cane spindle, but occur on the old and semi-nature leaves of the cane top. Primary infection of the leaves results when the organism passes upwards from the stem into the new leaves formed; the stripes produced in this case are different from those of the first type and are evidently encountered on the youngest leaves of the crown.

With the palm plant, as already said, the characteristic stripes are

PLATE I

Phot. 1 — Palm plantation at Granravien in Flacq district, with plant in foreground killed by the Gumming disease.

Phot. 2 — Young diseased palm plant. Advanced stage of the disease.

Phot. 3 — Blighted palm leaflets. Photo by transmitted light. Ilford Special Rapid Panchromatic plate and Ilford Gamma Filter.

Phot. 4 — Palm leaflets showing white striping (right) and circular spots (left) along the veins. Photo as in 3.

Phot. 5 — Palm leaflet with red vascular bundle. Photo on Ilford Special Lantern plate, by reflected light.

Phot. 6 — Stem of diseased palm plant showing gum ooze.

Phot. 7 — Heart leaf of young palm plant inoculated into the spindle with the palm bacterium. Note the lesions both around the inoculated centre near the junction of the two halves of the leaf, and from the tips backwards. Photo as in 3.

PLATE I.

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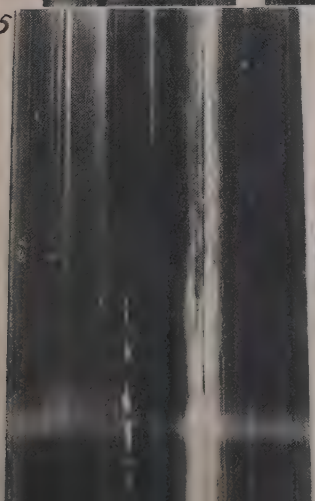
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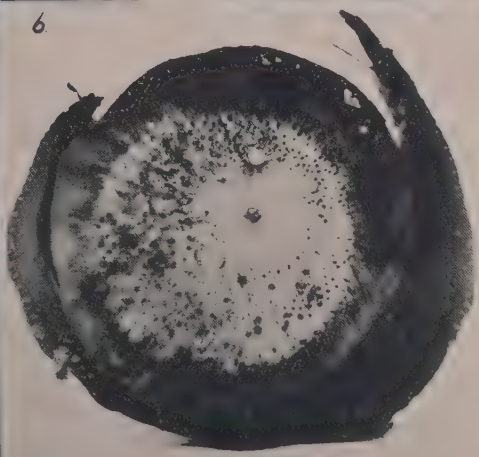
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met with even on leaves just unfolding from the central spindle. This suggests primary infection, and therefore, contrarily to what happens in the case of the sugar cane, the disease of palm *is not apparently in the first place a leaf disease.* Furthermore, the edges of the palm leaflets are not beset with saw-like teeth as are sugar cane leaves, and the epidermis of the former is much more heavily cuticularized than that of the latter, both of which factors diminish the possibility of mechanical wounds on the surface of the leaflets and consequently, of secondary infection being picked up by the leaves.

In an earlier paper on the subject (13), the writer analysing the case of tall plants showing the typical blight on a *succession* of young and semi-mature leaves, concluded as follows :—

" The relation of the blighted leaflets of one leaf to those of the other leaves, and the distribution of the diseased leaflets on the individual leaves suggest a spread of the disease from leaflet to leaflet, and from leaf to leaf, while the central spindle is pushing out into the air, and before the leaflets have separated from one another.

" The attack on a plant therefore, in all probability, runs as follows : The tip of one or of a few leaflets of the growing spindle becomes infected by the bacteria brought to it in drops of rain scattered about by the wind from an infected source. In case dry weather sets in the infection remains localized to but a few leaflets, the succeeding leaves remaining healthy until a new attack occurs. If after the onset of infection, prolonged wet weather is experienced, the bacteria from the few initially diseased leaflets are washed down by rain to successive lower leaflets of the same leaf and to those of succeeding younger leaves, resulting in a large number of the leaflets becoming infected on a *succession* of leaves."

The above theory is no longer held by the writer and he now considers that after the plant has *somehow* contracted the disease, lesions on the inner surface of the leaf-sheaths of the spindle are formed, as already described, and that the young leaves with their leaflets still closely pressed together, on growing past these lesions, become smeared over at their tips with the organism. In the confined atmosphere within the funnel of the spindle, a large number of the leaflets then become more or less partially rotted on a succession of leaves In the open air, the rotting stops and the badly affected parts of the leaflets dry out to the various shades of brown described ; from that time onwards, the blighting effect caused by the presence of the bacterium within the leaf tissues, proceeds but very slowly. From this theory which is now put forward as a result of further study of the disease, it would appear that the characteristic leaf blight produced by the disease is the result of secondary infection contracted from the plant itself by the leaflets of an already diseased plant.

Experiments to determine the manner in which the causative bacterium gets entry into a healthy plant have failed to give definite information*. The writer believes, however, that such entry is effected through

* see however the chapter on " Inoculations on palm of *B. vasculorum* from sugar cane, p. 33 ".

wounds suffered by the plant. Thus insect injury often occurs on the leaflets or on the issuing spindle itself ; numerous small mechanical cracks are present on the stem and on the sheaths, and during cyclonic weather, severe damage may be inflicted to the leaves. Furthermore, when the young palm leaf opens out from the spindle, the leaflets under the action of the wind tear away from a marginal fibre which connects them at the tip. Possibility therefore exists for bacteria if present in water on the leaf at the moment of rupture, to get sucked into the vascular bundles of the leaflet ; but inoculation experiments devised to test the possibility of infection by this method were negative.

Isolation of the pathogen.

A yellow bacterium was obtained in cultures of diseased palm tissues on Peptone Saccharose agar. From dilution plates of these cultures the organism was obtained pure and one of these pure cultures, derived from diseased stem tissue and labelled Palm A, was forwarded to the Imperial Mycological Institute and to the Lister Institute, London. Another isolate from the yellow tissues of a blighted leaflet, labelled PL 51, as well as the Palm A isolate, was used in inoculation tests.

Early inoculations into cane.

When the organism labelled Palm A had been isolated in 1934, inoculations were made by pouring a few drops of a suspension of the culture on the cut ends of a few DK/74 cane cuttings. These were planted, but the shoots which developed later remained apparently perfectly healthy, and the organism was then reported in 1935 as not being pathogenic to cane (19).

The observations made by North in Australia (7), that sugar cane sets heavily infected with *B. vasculorum* sometimes produce completely healthy shoots, were not then known to the author.

Identification of the pathogen.

As mentioned elsewhere (11), the cultural characters of the Palm A organism had been studied in 1935, and a similar study had been made in 1936, of different cultures of *B. vasculorum* isolated from sugar cane.

In March 1937, when the news of the discovery reported by Bell from Queensland (1) and already referred to, reached the author, he compared the characters of the pathogens in both series of experiments and found out that they were identical. Inoculations on sugar cane spindles (Pl. III, phot. 14) and cuttings then confirmed the identity of the palm pathogen with *B. vasculorum*.

The tests with sugar cane cuttings were carried out by North's method (7) on the variety D.K./74 which is resistant to the gumming disease ; controls remained healthy. The spindle inoculations were effected by pric-

king several times with an infected needle through unopened spindles of the susceptible cane variety 55/1182 ; controls again remained healthy.

It must be stated here that Hughes (4) inadvertently misrepresented slightly the facts when, speaking of the writer's " isolation of *B. vasculorum* from a heart rot of white palms (*Dictyosperma album*) and reisolation from plants of the same host and maize ", he added :

" The reisolates were identified at the Imperial Mycological Institute and on inoculation into sugar cane in Mauritius produced the characteristic symptoms of gumming disease ".

This statement would imply that the inoculations into sugar cane in Mauritius were effected as a consequence of an identification arrived at at the Institute. In reality the Institute simply confirmed the identifications made.

Inoculations into palm and reisolation of the pathogen.

(a) Young palm plants were sprayed with a suspension of the Palm A organism, and kept for two days in a moist atmosphere. No infection occurred.

(b) The blades of fully opened leaflets were inoculated on several occasions with the same isolate without success.

(c) Negative results were obtained by infection of the soil with a suspension of the organism.

(d) Young plants were inoculated by inserting an infection needle right down into the heart leaves and injecting into the spindle a few drops of suspensions of both PA and PL_{51} isolates. In about 30 days, the inoculated plants showed brown lesions around the punctures ; a strong infection was also visible on one plant running downwards from the tip of the leaf (Pl I, phot. 7). The bacterium was reisolated from the affected leaf and produced gumming stripes and gum ooze when inoculated into sugar cane leaves and cuttings respectively. Gum ooze was also produced when the stems of the inoculated plants were sectioned later.

(e) Suspensions in sterile water of various cultures obtained were on several occasions inoculated into young *D. album* and *D. rubrum* plants by stabbing the stems with an infected needle. As a result, the central spindle of the plants was dead or dying one to 2 months later. On sectioning the stems of the dying plants, gum ooze was produced by the bundles. The pathogen was also reisolated from the stem tissues and its identity confirmed by inoculation into sugar cane spindles and cuttings. (Pl. III, phot. 14).

Inoculations into Maize plants.

Maize plants inoculated with a suspension of the Palm A isolate by

PLATE II

Phot. 8 — Maize leaf from plant inoculated with the palm bacterium (culture PA). Early stage of leaf stripe. Photo by reflected light on Ilford S. Rapid plate, no filter.

Phot. 9 — As in 8. Later stage in the development of the leaf stripes. Photo by reflected light on Ilford Special Lantern plate, no filter.

Phot. 10 — Maize leaves from plant inoculated with *B. vasculorum* from sugar cane. Photo as in 3.

Phot. 11 — Maize leaves from plant inoculated with the Thysanolæna isolate, (culture TS_{11}). Photo as in 3.

Phot. 12 — Large cavity in stem of maize plant inoculated with *B. vasculorum* from Sugar cane. Photo on Ilford Auto-Filter plate.

Phot. 13 — Stems of maize plants inoculated with isolates from Thysanolæna. Note the knife-cuts, the malformation of the top and the bending over to one side.

PLATE II.

means of a hypodermic syringe produced yellowish stripes on the young leaves after the inoculations (Pl. II, phots. 8 and 9). Later, the plants were uprooted and their stems and leaf sheaths produced yellow ooze on sectioning; yellow fibres and brown water-soaked lesions and cavities were present in the pith ; knife-cuts were also visible on the stems. Controls remained healthy. A photomicrograph of a bundle from a cross section of the stem of one of the diseased plants is shown in Plate V phot. 28.

Blade inoculations gave in general no infection ; in but a very few cases were pallid green stripes of irregular margin and width produced from the punctures. The causative organism was reisolated from the yellow leaf stripes and from the stem tissues of the inoculated plants. Positive results were obtained with the reisolates on sugar cane leaves and cuttings

Inoculations on Palm of B. vasculorum from sugar cane.

Young palm plants were inoculated with suspensions of *B. vasculorum* from cane by stabbing the stem with an infected needle. The spindles of the plants died in about 2 months. Upon sectioning their stems, yellow gum oozed from the bundles. *B. vasculorum* was reisolated from the diseased tissues and its identity confirmed by inoculation into cane leaves.

Inoculations into the spindle were made by injection, with the needle of a hypodermic syringe inserted vertically downwards into the heart leaves. In about 30 days, light brown lesions with water-soaked margins were visible around the punctures. Sixty days after the inoculations, the spindles of the plants were dying from the base upwards. The inner surface of the sheath of the leaf surrounding the heart showed oval, water-soaked, depressed spots with extruded gum drops, and the stem on sectioning produced tiny drops of gum from the cut bundles.

Inoculations upon the opened blades of palm plants were also made; they were negative on a first occasion, but in another attempt, one out of 7 leaflets inoculated picked up a mild infection. In this instance, 3 months after the inoculations, there was no evidence of infection *to the naked eye*, but upon examination with the pocket lens by transmitted light, a few fibres in the immediate vicinity of the inoculated area were seen slightly discoloured yellowish-red for about 3/4" upwards from the punctures. The slide test was positive.

It therefore appears that infection may be picked up from wounds by open palm blades, without the production of visible stripes even after the lapse of several months. It is possible therefore that in certain of the leaf inoculation experiments carried on with the palm plant and recorded as negative, a mild infection actually ensued, which remained unnoticed. From such infection the bacterium may perhaps travel downwards, unattended by conspicuous stripe formation, and subsequently set up infection in the stem.

Conclusion.

The results of the cultural study (see Part III) of the bacterium isolated from, and proved pathogenic to the palm *Dictyosperma album* Wendl. et Drude, and the investigations described above, have proved that bacterium to be *Bacterium vasculorum* (Cobb) Gr. Smith.

Thysanolæna maxima (Roxb.) Kuntze.

Discovery of the disease.

On the 13th of April, 1935, diseased stems of the "broom bamboo" *Thysanolæna maxima* (Roxb.) Kuntze, were submitted to the writer by Mr. J. Duhamel, the Plant Inspector of the Department of Agriculture, who had discovered the disease at Midlands, on the central plateau of the island. That officer observed the exudation of gum from the diseased stems when cut.

Thysanolæna maxima is a tall grass, growing into thick clumps and reaching a height of 8 to 10 feet; it is often used for hedges, and brooms are made from its inflorescence. It is occasionally found growing wild in the island, near the sites of old dwellings.

Early investigations.

When the disease was discovered, a yellow bacterium was isolated by the writer from the diseased tissues, and the organism was inoculated into sugar cane cuttings. No infection was observed on the shoots which developed and the conclusion was drawn that the organism was not pathogenic to cane.

As a result, however, of the identification of the causative agent of the palm disease described above, the investigations on the disease of Thysanolæna were resumed in March 1937.

Symptoms.

Affected leaves show broad, diffuse stripes proceeding from the tips or from the edge of the leaf near the tip backwards. The stripes pass through various colour changes which apparently vary somewhat according to climatic conditions. On the moist central plateau at Midlands, they have been found to change (16) from Spinach Green or Forest Green, the normal colour of the leaf, to Asphodel Green and to Vetiver Green drying out to Smoke Gray and finally to somewhat Deep Olive Buff. In a drier region of the island, at Mon Désert (Moka), the dull green stripes as above described have seen to dry out to Buffy Brown and sometimes to Mummy Brown or Olive Brown at places on the leaf, and to be bordered by a narrow yellowish margin.

The stripes are very irregular in outline and may reach a width of ten to twenty millimetres or more ; they always taper from above downwards.

Sometimes instead of the stripes, the blades may show patches of similarly affected tissue, elongated in the direction of the length of the leaf. White veins may be present chiefly on the topmost leaves of affected shoots, the tissue bordering the veins forming a faint yellow stripe studded with numerous white dots or specks (Pl. III, phot. 18)

On the underside of the leaves a Slate Purple to Dark Vinaceous Purple coloration is generally present and, very often, the leaves fold over from the under surface along a stripe, or partially roll up on the affected side of the blade.

The attack on the plant seems to occur chiefly by secondary infection of the leaves, the edges of which are beset with small sharp teeth, chiefly in the upper portions of the blade. From the leaves, the causative organism passes into the stem, and thence up again into the new leaves produced, ultimately causing the death of the growing point and the rotting of the leaves of the spindle.

On transversely cutting a diseased stem towards the top, yellow to brown fibres are seen present, chiefly at the nodes, and a longitudinal cavity often containing a certain amount of thick yellow gum is noticed in the internodes. Drops of yellow gum also slowly ooze from the cut vessels of the stem and sheaths. As the gum also oozes from the inner surface of the sheaths, the enclosed portions of the stem are often covered with gum and often also show the lesions known as knife-cuts. A photomicrograph of a section of a diseased stem will be seen in Pl. V, phot. 30.

Isolation of the pathogen.

Cultures of leaf stripe tissue (TL), of newly diseased stem tissue (TS) and of the gum oozing out of the bundles from disinfected portions of stem (TG), yielded a light yellow bacterial growth, already pure in many cases. Isolations of the pathogen were made from dilution plates of these cultures. The pure cultures obtained were identified as *B. vasculorum* by inoculation into sugar cane leaves and cuttings (Pl. III, phot. 15 and 16). A culture of the pathogen, labelled TS_{11}, was forwarded to the Imperial Mycological Institute and to the Lister Institute, London, in 1937.

Inoculations on Thysanolæna.

Suspensions in sterile water of the pure cultures obtained were inoculated into Thysanolæna leaves ; stripes were produced in about one month. These were of two types : in some the bacterium travelled along a vein from the inoculated area towards the tip of the leaf, resulting in the production of a white, linear stripe, diffusing laterally into a faint yellowish stripe of irregular width (Pl. III, phot. 19). In others, the stripe was

PLATE III

Phot. 14 — Stripes produced on sugar cane leaves from spindle inoculation with the palm bacterium, culture PA, left blade, and with a reisolate from a palm plant inoculated with culture PA, right blade. Photo on Ilford Special Rapid Panchromatic plate. No filter. Transmitted light.

Phot. 15 — Stripes on cane leaves from blade inoculations with *B. vasculorum* from cane (GD) and various isolates from Thysanolæna (TG_{12} - TMD_1). The circles on the leaves enclose control punctures. Photo as in 3.

Phot. 16 — Gum ooze from DK/74 cuttings inoculated with isolates from Thysanolæna. The cuttings were left in the soil for about a fortnight, then sweated according to North's technique.

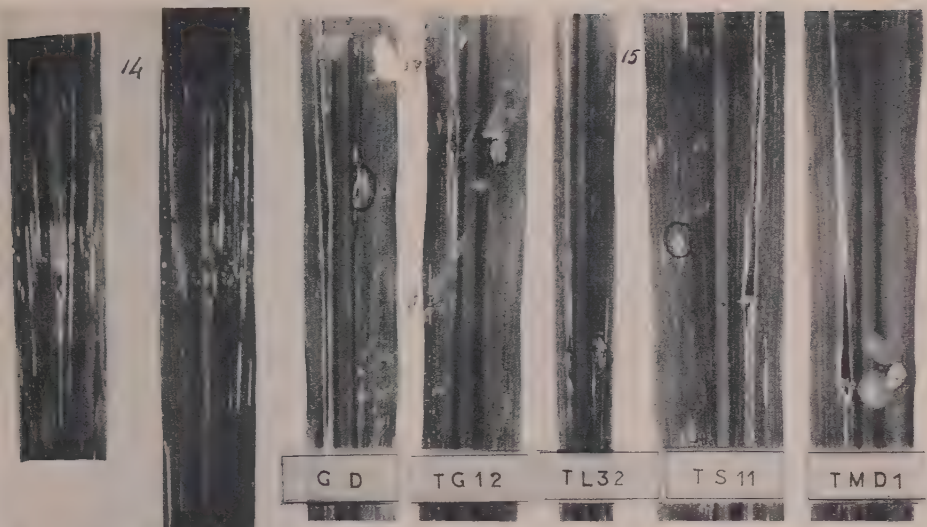
Phot. 17 — Gum ooze from the stems of maize plants inoculated with the Thysanolæna isolate TS_{11}.

Phot. 18 — Natural infection of Thysanolæna leaves from Midlands. Photo by Transmitted light on Ilford S.R. Panchro. plate and Wratten F filter.

Phot. 19 & 20 — Stripes on Thysanolæna leaves from blade inoculations with isolates from Thysanolæna.

Phot. 21 — Stripes on Thysanolæna leaves from spindle inoculations with *B. vasculorum* from cane (right) and a reisolate of same from maize (left).

PLATE III.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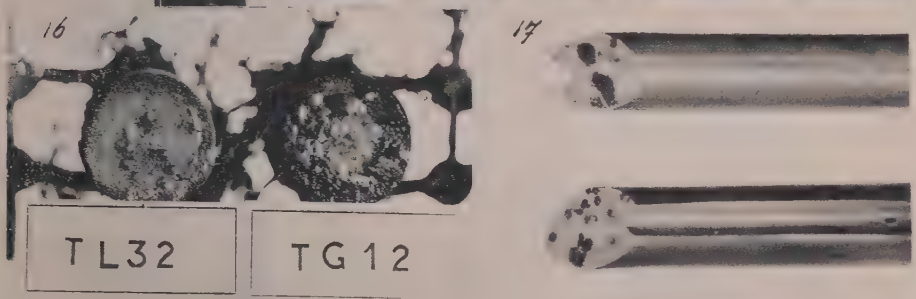
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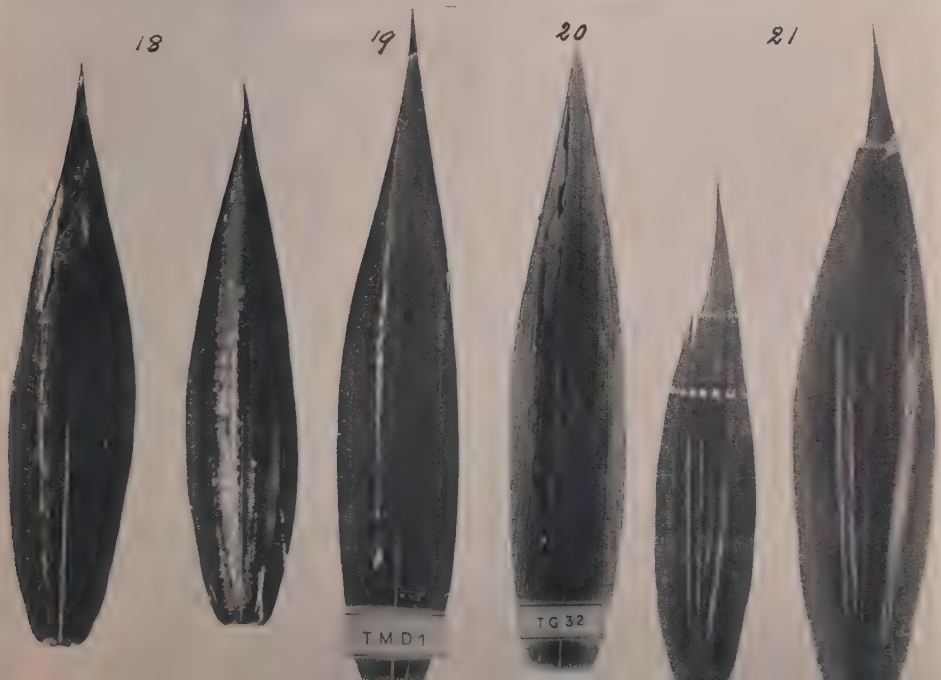
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TG 32

broad, dull green, diffuse, with water-soaked margins, of very irregular size and shape, and running in general both upwards and downwards from the area of inoculation (Pl. III, phot. 20).

Inoculations were also made by puncturing across the base of the spindle by means of an infected needle. The three or four leaves subsequently produced — the first two of which in general having been pierced through by the needle — showed long stripes of the linear type, in general visible a certain distance away from the punctures. The subsequent leaves produced showed no trace of infection and the plants, under the conditions at the Central Experiment Station, threw off the disease.

Young intermodes were also inoculated by puncturing them through with the infected needle ; as a result death of the heart leaves and of the growing point subsequently occurred and the inoculated stems oozed gum upon sectioning.

Reisolation of the pathogen.

From the tissues of the stripes of the inoculated leaves, cultures of the organism were obtained on Wilbrink's agar. The cultures were inoculated into healthy sugar cane leaves and cuttings and gumming symptoms obtained.

Inoculations on Maize.

The pure cultures obtained from Thysanolæna material were inoculated into the stems of young maize plants by means of a hypodermic syringe, and also by means of a needle. Control plants were kept.

In 8 to 9 days, stripes similar to those produced on maize by the palm bacterium (Pl. II, phot. 8, 9) and by *B. vasculorum* from cane (Pl. II, phot. 10) were present on the leaves of the inoculated plants (Pl. II, phot. 11) and the vessels of the stems oozed gum on sectioning later (Pl. III, phot. 17). In the case of the stem inoculations, knife cuts (Pl. II, phot. 13) were visible on the stems and the exudation of gum from the inner surface of the sheaths was rather abundant. The leaves of the spindle also became twisted and tied together, and a considerable bending over to one side occurred (Pl. II, phot. 13). Such a malformation of the top is not mentioned by Ivanoff (5), but is described by Hughes (4). In the author's experiments, it was not produced by the isolates from maize, sugar cane and palm.

Reisolations of the pathogen were made, and these gave positive results upon inoculation into sugar cane leaves and cuttings.

Inoculations into palm.

Young palm plants were inoculated with the TS_{11} isolate ; as a re-

sult the spindles died in about 2 months, and gum oozed from the bundles when the stem was sectioned.

Reisolations of the pathogen were made and the cultures obtained produced gumming stripes when inoculated into canes leaves.

Inoculations of the palm and sugar cane bacteria on Thysanolæna.

Inoculations were made on several occasions with different isolates of the palm bacterium and of *B. vasculorum* from cane into the spindles and blades of Tysanolæna shoots. A culture of *B. vasculorum* reisolated from maize leaf stripe produced by a plant inoculated with *B. vasculorum* from sugar cane was also similarly used. As a result, stripes were produced in about 20 days from all the spindle inoculations (Pl. III, phot. 21), but save in the case of the palm bacterium, the blade inoculations remained negative. A photomicroraph of a cross-section of a leaf from a Thysanolæna spindle inoculated with the palm pathogen is show in Pl. VI, phot. 32.

Conclusion.

The results of the investigations carried out on the disease of *Thysanolæna maxima* (Roxb.) Kuntze have proved it to be caused by *Bacterium vasculorum* (Cobb). Gr. Smith.

Part II — Artificial Hosts of *B. vasculorum* (Cobb) Gr. Smith.

Introduction.

It has been established in Part I of the present paper that the writer in 1932 isolated from a diseased maize plant a bacterium which reproduced the disease upon inoculation into maize. Proofs have also been put forward to the effect that the bacterium was *Bacterium vasculorum* (Cobb) Gr. Smith, although the identity of the organism was not then known to the writer.

Ivanoff in 1935 (5) published the results of experiments he had carried out at Wisconsin in 1934, establishing that maize, *Zea mays* L. and sorghum, *Holcus sorghum* L. contracted infection upon inoculation with the sugar cane gumming disease organism.

From 1935 to 1938, Hughes (3, 4) in Queensland further investigated the subject and his successful infection of maize was briefly recorded by Bell (1). Hughes added the following plants to the list of artificial hosts of *B. vasculorum* :— Grain and sweet sorghum, *Sorghum* spp. Snow ; Bastard sorghum, *Sorghum verticilliflorum* Stapf. ; Sudan grass, *Sorghum*

sudanense Stapf. ; Johnson grass, *Sorghum halepense* (L.) Pers. ; Para grass, *Brachiaria mutica* (Forsk.) Stapf. ; Elephant grass, *Pennisetum purpureum* Schum. He failed to obtain infection with Guinea grass, *Panicum maximum* Jacq.

In researches from 1937 to 1939, the writer successfully inoculated the following plants : Job's tears, *Coix lacryma-jobi* L. ; Guinea grass, *Panicum maximum* Jacq ; the tall bamboo *Bambusa vulgaris* L.* ; and the coconut palm, *Cocos nucifera* L.

Streaks were obtained on leaves of the grass *Paspalum paniculatum* L., but as *B. vasculorum* could not be recovered from the tissues of that plant, its reaction is held as doubtful. The following other plants which were tested reacted negatively : *Canna* sp. ; *Hedychium coronarium* Kœnig ; *Commelyna benghalensis* Forsk. ; *Cenchrus echinatus* L. ; the royal palm *Roystonea regia* L., and *Argemone mexicana* L.

The author deliberately extended his tests to include monocotyledonous plants belonging to various families, because his discovery of the occurrence of the organism on palms proved that it was not confined to the Gramineæ. He even went the length of subjecting to inoculation the Mexican poppy, *Argemone mexicana* L., a plant belonging to the family Papaveraceæ, of the Dicotyledons. There were reasons for this choice, for he recently isolated a bacterium from the plant, cultures of which are inseparable to the eye from those of *B. vasculorum*. The organism is different from *Bacillus papaveris* Ayyar ; many of its reactions resemble those of *B. vasculorum*, but it is not pathogenic to cane.**

The plants which were investigated by the writer, except *Argemone mexicana*, were inoculated with cultures of isolates from the sugar cane, palm, and Thysanolæna. *A mexicana* was inoculated only with *B. vasculorum* from cane. The methods of inoculation used were in general two in the case of the monocotyledonous plants : 1o. leaf blade and 2o. spindle inoculations. In the first, North's method already referred to was employed ; in the second, a drop of a thick suspension of the organism in sterile water was placed on the outermost leaf sheath and a sterile needle plunged through in such a direction as to pierce the innermost roll of young leaves. On withdrawing the needle, the whole drop of suspension was sucked in mechanically. In some cases a hypodermic needle was used for inoculating the suspension into the spindle. In the case of the tall bamboo, a third method, the inoculation of the stem, was also employed. In the researches on *Argemone mexicana*, only the first and third methods were used.

* In a previous report on the subject (13) the writer wrongly referred to the bamboo plant as *Dendrocalamus giganteus* Munro.

** The writer has lately identified this bacterium as *Bacterium papavericola* Bryan & Mc Whorter.

PLATE IV

Phot. 22 — Blade inoculations on *Coix-lacryma-jobi* L.
right leaf : *B. vasculorum* from cane.
left leaf : The Thysanolæna pathogen, culture TS_{11}.
The circles enclose control punctures.

Phots. 23 & 24 — Spindle inoculations on *C. l-jobi* L.

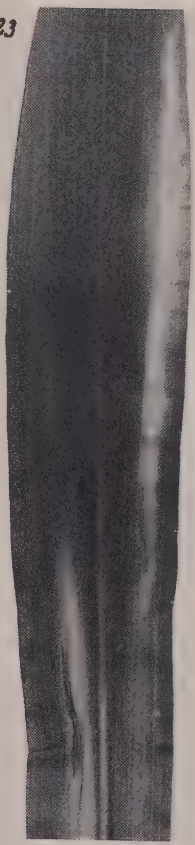
Phot. 25 — White vein on leaf of *Panicum maximum* Jacq. from spindle inoc. with TS_{11}. Photo as in 3.

Phot. 26 — Blade inoculations on leaves of tall Bamboo ; from right to left, leaves inoculated respectively with TS_{11}, PL_{51} and *B. vasculorum* from cane. Photo as in 3. The several rows of fine punctures towards the top of the middle leaf were caused by insect punctures before the leaf unrolled from the spindle.

PLATE IV.

22

23



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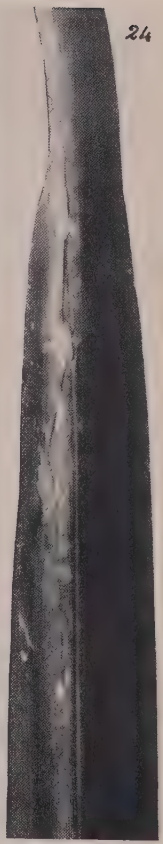

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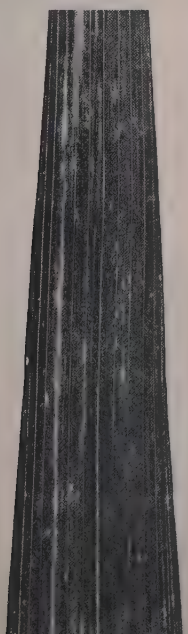

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In all cases where infection was picked up, *B. vasculroum* was reisolated from the inoculated plants and the identity of the reisolates confirmed by inoculation into sugar cane leaves and cuttings. Controls were always kept, and remained healthy throughout the experiments.

The results obtained are briefly described below.

Job's tears, *Coix lacryma-jobi* L.

(1) *Leaf blade inoculations.* Contrarily to what happens in the case of maize, the fully opened leaves of *Coix lacryma-jobi* L. easily look up infection. Fourteen days after the inoculations, the inoculated areas showed the central tissues dead and bordered by a very narrow yellow zone. Narrow, yellowish patches along the veins were also sometimes present upwards or downwards from the holes. They started as small translucent areas at intervals on one side or on both sides of the vein, and elongated and broadened into yellowish stripes of very irregular size which rather rapidly turned brown and dried out (Pl. IV, phot. 22).

(2) *Spindle inoculations.* (with hypodermic needles). In ten to fourteen days after the inoculations, stripes were visible on the youngest unfolding leaves ; in some cases the heart leaf was dead or dying by that time. The stripes began as short, slightly thickened, interrupted lengths of whitened vein along the course of the major veins, the latter thereby often exhibiting a beaded appearance The white discoloration enlarged laterally, elongating meanwhile into longer or smaller patches. When far apart on the affected vein, the patches finally formed a stripe of an interrupted or fragmented type. When the original beads were close together on a vein, they fused end to end, forming long white stripes with diffuse borders. In many cases, the leaves which pushed out of the spindle after the inoculations, whether punctured or not, showed even in their earliest stages, fully formed white stripes in which the development just described was not observed. The leaf tissue in the chlorotic regions became studded with small, translucent dots, streaks or blotches, which enlarged chiefly in the direction of the veins, then turned brown and dried out (Pl. IV, photo 23, 24).

In the case of the inoculations carried out with the isolate from Thysanolæna, the leaves pierced through by the needle showed after ten days a withered area surrounded by a transparent border, around the punctures. Even at so early a time, the lesions sometimes extended up and down from the punctures, as stripes of transparent tissue, with the centre drying out. That isolate proved more virulent on Coix, in causing the rapid death of the inoculated plants.

A photomicrograph of a diseased bundle from a Coix leaf inoculated with *B. vasculorum* from cane is shown in Pl. VI, phot. 33.

Guinea grass, *Panicum maximum* Jacq.

Guinea grass is apparently highly resistant to artificial infection with *B vasculorum*. Hughes (4) reports in the following terms failure to infect the plant by inoculation of the heart with the hypodermic needle :—

" Guinea grass was the only inoculated grass which failed to become infected. Inoculation wounds on the leaf blades were small and inconspicuous and healed normally in all shoots. Occasionally, vascular bundles which had been pierced by the needle showed slight chlorosis, but *B. vasculorum* could not be cultured therefrom ".

(1) *Leaf blade inoculations.* Of 10 leaves which were inoculated with the three isolates, none picked up infection.

(2) *Spindle inoculations.* On the whole 14 spindles were inoculated by one needle stab each. Six days later, a few veins on two leaves from shoots inoculated with the pathogen from sugar cane were seen to have turned white for a length of about 3 inches from the punctures upwards. The midrib showed an elliptical, yellowish lesion, 3-5 mm. long, bordered by a rather narrow water-soaked margin, where it had been pierced by the needle. The lesion, however, did not develop further. After 12 days another heart leaf showed a white vein about $\frac{3}{4}$ inches from a puncture, running downwards for about 3 inches.

Ten days after the inoculations, the expanding heart leaf of a shoot inoculated with the isolation from Thysanolæna showed two white veins running downwards from the punctures, and the preceding leaf, which too had been pierced by the needle, was also then noticed to be showing too short white veins One of the affected veins of the younger leaf was about 8 to 10 inches long, and very conspicuous ; it presented a beaded aspect in the lower part of its course. In its upper portion, lateral diffusion had occurred at places, forming small lengths of faint, narrow, yellowish stripe.

The chlorotic lesions made no further progress and even, contrary to expectations, gradually faded out. Twenty days after the inoculations, the long stripe was photographed (Pl. IV, phot. 25) ; it was much less conspicuous than at first. The slide test proved positive, and the pathogen was reisolated from the tissues of the stripe.

The tall bamboo, *Bambusa vulgaris* L.

On 10.12.37, forty leaves and fifteen spindles were inoculated. No infection resulted from the blade inoculations.

Spindle inoculations. Most of the inoculated spindles picked up infection. The first leaves opened out 6 days after the inoculations, and several

of them showed short, narrow, yellowish-green stripes from some punctures. On 22 12.37, white veins and narrow diffuse white stripes were present on the next leaves to open out; yellowish stripes developed about the white veins, and the central tissues of the stripes dried out early. (Pl. IV, phot. 26). A few longitudinal pallid green stripes of irregular outline were also present, which turned light brown before drying, and about which folding over of the leaf towards the upper surface occurred. Some of the stripes had occasionally a purplish coloration.

A photomicrograph of a diseased leaf from a spindle inoculated with *B. vasculorum* from cane is shown in (Pl. VI, phot. 34).

Stem inoculations. On 14.2.38, three young shoots 4 to 8 ft. high were inoculated by several needle pricks in the tender tissues just above a node. Several side branches were also similarly treated.

On 21.2.38 the pricked portion of the internodes was found to have become much swollen; it was about 1½ times the diameter of the upper part of the same internode. On 7.3.38, i.e. 21 days after the inoculations, one of the treated side shoots was cut, sectioned in the inoculated region and also split longitudinally.

It was observed that in the internal regions corresponding to the swollen portion, rounded sclerotic masses had formed which tended to block the natural hollow of the stem. Small drops of gum also oozed from cut fibres.

On 4.4.38, i.e. 49 days after the beginning of the experiment, the clumps of side branches which had grown out from the buds of the node just below the inoculated internode were seen to be more stunted than the branches from the upper and lower nodes. Several spindles of these side branches had died out and of the topmost leaves, some were puckered and twisted together, and several were more or less completely white or "etiolated". The discoloration of the leaves took the form of longitudinal white bands, but more frequently, it was of a streaky nature, either numerous fine white streaks with much green still left, or completely blanched leaves with very few green streaks present (Pl. V, phot. 27). The effect on the etiolated leaves was clearly not due to the presence of the organism in the discoloured tissues; it suggested rather a toxic principle diffused into otherwise healthy leaf tissue and the presence of which prevented the formation of chlorophyll during the development of the young leaves. Similar etiolation is common with sugar cane leaves on shoots affected by the gumming disease.

The other shoots inoculated were left for further observations, but some time after the above notes had been taken, it was discovered that labourers in search of bamboo poles had not noticed or had ignored the

PLATE V

Phot. 27 — Etiolated leaves of the tall bamboo from spindle inoculation with *B. vasculorum* from cane.

Phot. 28 — Photomicrograph of Transverse section of Maize stem from plant inoculated with the palm pathogen (culture PA), x 160. Slide stained by Goodpasture's method, Plate Ilford S.R. Panchro., Filter Zeiss-Ikon G_8.

Phot. 29 — Photomicrograph of transverse section of stem of naturally diseased palm plant, x 160. Stain : Carbol Fuchsin Plate. etc. as in 28.

Phot. 30 — Photomicrograph of transverse section of naturally infected Thysanolæna stem, x 160. Stain, etc. as in 29.

affixed labels and had cut the shoots under observation. The bamboo clumps used were growing wild on the banks of a river near the Experiment Station.

The Coconut palm, *Cocos nucifera* L.

(1) *Leaf blade inoculations.* None effected.

(2) *Spindle inoculations.* On 18.3.39, two young coconut seedlings each were inoculated with suspensions of the organism from the three sources used. The fibrous sheaths of the external leaves were removed and a stout needle was thrust obliquely downwards into the younger part of the spindle to reach the tissues of the heart leaves. The needle of the hypodermic syringe was then inserted into the wound and a certain amount of suspension injected. Six controls were kept.

On 24.4.39, one of the plants inoculated with the Thysanolæna culture showed the following symptoms :— Several leaflets of the still undivided leaf, as well as the midrib of that leaf had rotted in the regions where they had been pierced by the needle. From the rotting areas and from the punctures on the other leaflets, long, thin yellowish-red bundles were observed, running both upwards and downwards.

On 29.4.39, the punctured zones on the heart leaf of the second plant inoculated with the same isolate came out into the air, and on pulling the leaflets apart, they showed similar long, yellowish-red fibres. These oozed gum by the slide test, and yielded *B. vasculorum* in culture.

The writer was away from office on sick leave from the end of May 1939 to August of the same year. When he resumed work in the following September, the two plants above mentioned, together with those inoculated with the sugar cane bacterium had died out and had become completely rotten.

Conclusion.

In its effect upon some of the plants which picked up infection, chiefly with *Coix lacryma-jobi* L., the isolate from Thysanolæna appeared to be different to a slight extent from the isolates from palm and from sugar cane.

Part III. — Characters and Reactions of the Gumming Disease bacterium isolated from Sugar cane, Maize, Palm and Thysanolæna.

The following laboratory numbers employed during the researches are assigned to the different bacteria in the descriptions which follow :—

PLATE VI

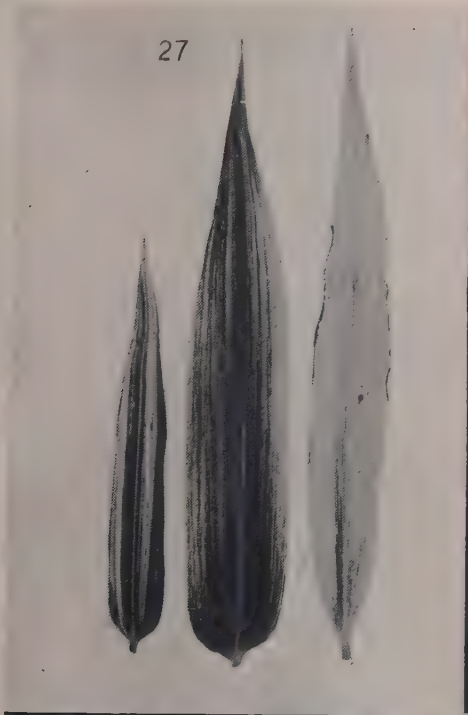
Phot. 31 — Photomicrograph of T. Section of naturally infected Palm leaf, × 160. Stain : C. Fuchsin. Plate Ilford S. R. Panchro. Filter Zeiss Ikon G_3.

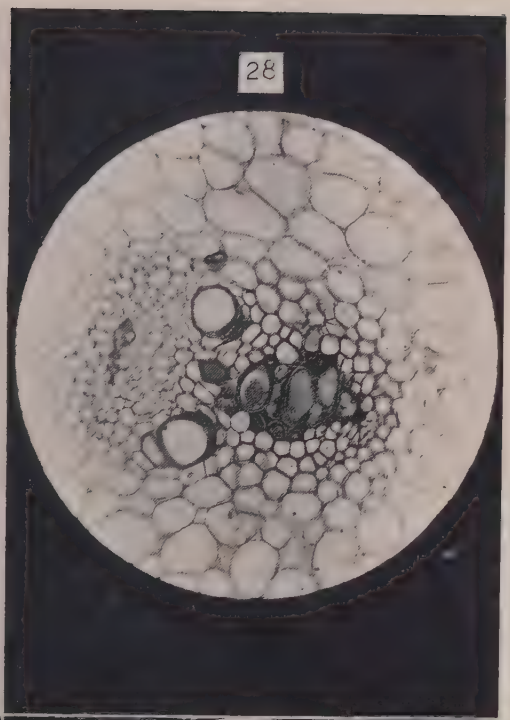
Phot. 32 — Photomicrograph of T. Section of Thysanolœna leaf from plant inoculated with the palm pathogen, culture $PL_{3.1}$; × 350. Stain, etc., as in phot. 31.

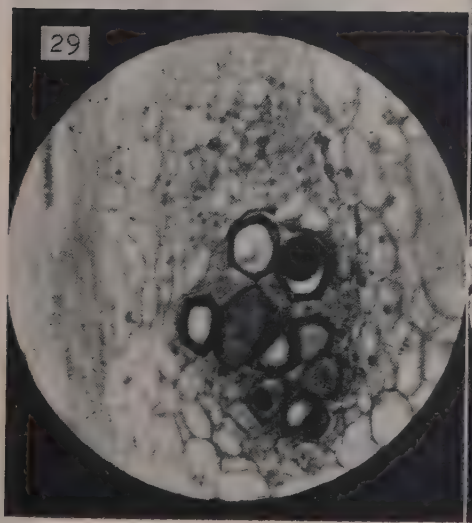
Phot. 33 — Photomicrograph of T. Section of *Croix lacryma. jobi* leaf inoculated with *B. vasculorum* from cane ; × 350. Stain, etc. as in phot. 31.

Phot. 34 — Photomicrograph of T. Section of Tall Bamboo leaf, inoculated into the blade with *B. vasculorum* from cane ; × 350. Stained by Cottrell-Dormer's method. Plate and filter as in phot. 31.

PLATE V.







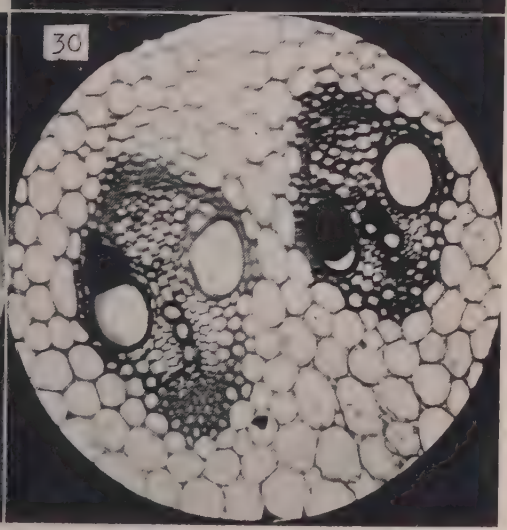
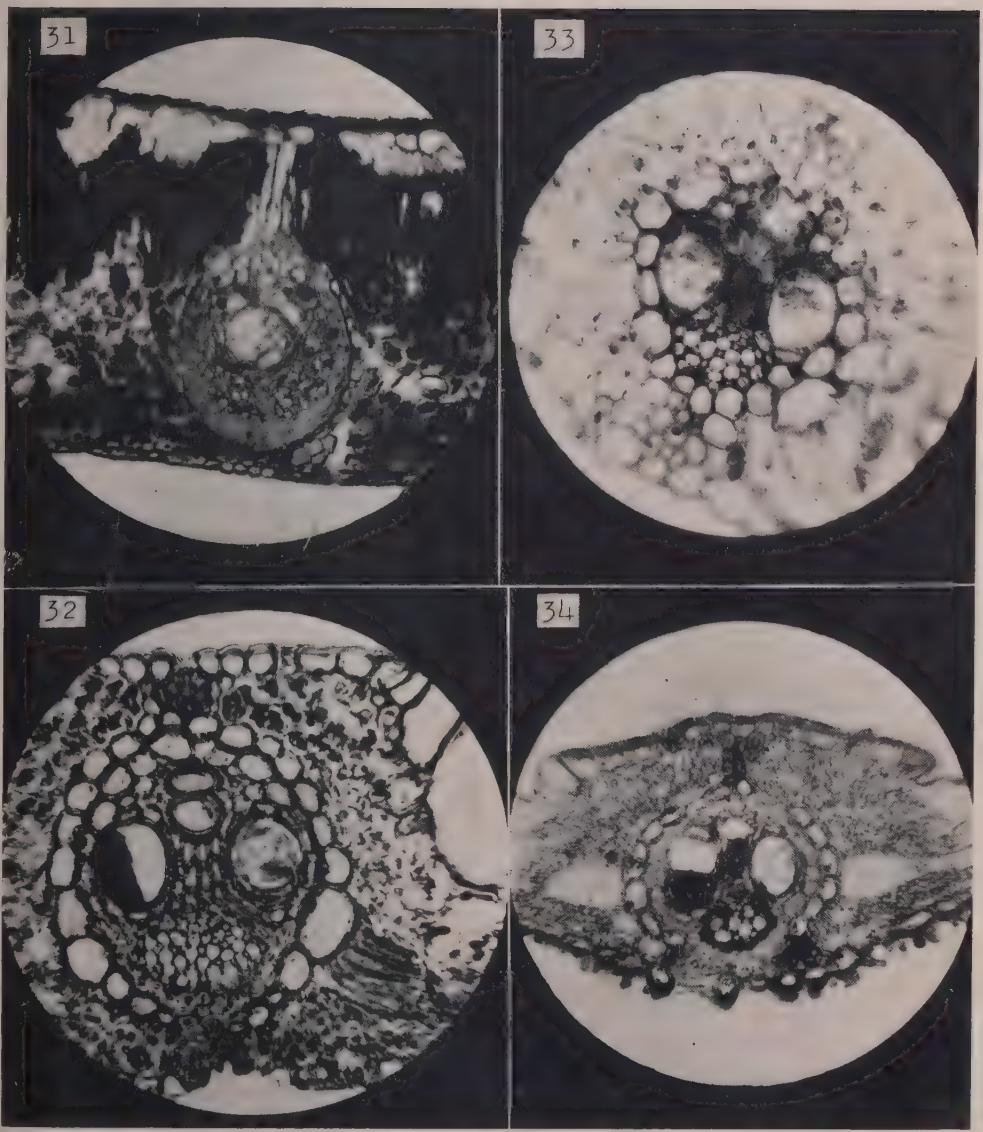


PLATE VI.



GA and GD refer to cultures of *B. vasculorum* from cane.
PA and PL_{51} " " " " " " palm
TS_{11}, TG_{32}, TL_{32} and TL_{82} " " " Thysanolæna.

We begin by giving the notes which were forwarded by The Imperial Mycological Institute about the maize organism sent to Kew in 1932, the characters of which were not studied by the author.

The maize bacterium isolated in Mauritius in 1932.

Letter from S. F. Ashby, dated 11th October, 1932.

" I have done a few cultural tests to see if it resembles *Aplanobacter stewarti*, although it seemed to be actively motile in young culture. It grew readily and copiously in Wilbrink's agar (just acid to phenolphtalein — about 1° F). Substituting 12% gelatine for the agar in Wilbrink's medium it grew moderately, causing a slow but quite appreciable liquefaction in 12 days at 23° both on slant and stab cultures (initial reaction of gelatine about 16° F.). It grew for a time freely on potato blocks (primuline yellow) flowing off as a yellow slime ; growth, however, was not long continued as in *B. malvacearum* and scrapings from below it after a month showed little evidence of diastatic activity (iodine test).

In plain skim milk and azolitmin milk at 23° C. a clear whey about 0.5 cms. deep separated at the top after 3-4 days and there seemed to be a slight initial alkalinity developed ; the azolitmin was gradually reduced. After a month, however, the reaction caused no change in neutral litmus paper and the bulky curd was nearly as opaque as the milk in the control. It is possible, however, that there may be clearing after some weeks more. Growth in milk was good as a considerable yellow deposit formed. The form differs from *Apl. stewarti* in being motile, liquefying gelatine, causing a separation of whey and curd in milk and in growing more freely on potato. It resembles rather strongly the strain of *B. vasculorum* which North sent some years ago ; that strain, however, gave to milk a markedly alkaline reaction. It differs from all pathogens hitherto described from maize. "

Letter dated 22nd December, 1932 :—

" Three out of four cultures, after three months in separated milk at 23° C., have cleared fully and the fourth is half cleared and half translucent ; all turn red litmus paper promptly blue. Controls have remained unchanged and neutral. "

In a reply to queries from the writer, Mr. Ashby stated on 27.2.39.

" The ' bulky clot ' which I mentioned was a soft clot, so fine and bulky as to be scarcely visible, just as in *B. vasculorum*, with subsequent slow clearing and never at any time an acid reaction.

I did not make a plate test for diastatic activity, but tested a fairly old potato block culture with iodine. Your plate method would be more sensitive.

I quite believe the organism was a strain of *B. vasculorum* ".

Characterizations of the bacteria. The characters of the different isolates are given in Table I for purposes of comparison

Some of the investigations made are described below in some detail,

because they throw somewhat more light upon the characters of the different isolates.

The experiments were carried out with 20—24 hr. old transfers of the organisms; the media used were with a basis of beef bouillon and were brought up to pH 7. The investigations were repeated on another occasion, using media from Difco Standardised products, the pH of which was not tested. Most of the methods employed are those recommended by the Committee on Bacteriological Technique of the Society of American Bacteriologists (6).

Form and Size. Photomicrographs of the bacteria from cane, palm and Thysanolæna are given in Plate VII, phots. 36 to 42. The Thysanolæna organism appears to be slightly shorter than the other two.

Gram Stain. The ordinary Gram technique and the modifications by Hucker and by Kopeloff and Beerman were employed. The bacterial suspensions were mixed sometimes with *Streptococcus* and sometimes with *Staphylococcus* cultures before the preparation of the smears.

Acid-Fast Test. The methods of Ziehl-Neelsen and of Mallory and Wright were used.

Flagella Staining. Both Gray's and Plimmer and Paine's techniques were followed ; the former yielded the best results. The organisms have one polar flagellum ; they have a thick capsule of gum which takes the stain, causing them to appear ovoid or spherical. The palm bacterium generally showed the organism thus thickly stained (Pl. VII, phot. 41), but some preparations from a different transfer of the same isolate showed no trace of sheath (Pl. VII, phot. 40).

Through irregular staining, slides or portions of slides sometimes showed the capsule heavily stained, but not the bacterial cell. The reverse was also observed, where the bacterial cell and the external wall of the capsule were deeply stained, but not the bulk of the capsule. In the latter case, the flagellum was noticed as a prolongation of the wall of the sheath ; it was distinctly not attached to the bacterial body itself. Clumps of bacteria were sometimes observed (Pl. VII, phot. 41).

Capsule Test. The investigations above described had given indications of the presence of a capsule with the three organisms studied. Both Gins' and Anthony's methods were also used. In the first, a blank test was made with the Indian ink used (Gurr's, special for microscope work) ; no bacterium was found in the ink. In the second method, the capsules were but very faintly noticeable.

Spore stain. Synder's modification of Dorner's method was employed.

TABLE I — Comparative characterizations of the bacterium from cane, maize, palm and Thysanolæna.

	B. vasculorum from cane	The Maize pathogen	The Palm pathogen	The Thysanolæna pathogen
MORPHOLOGICAL CHARACTERS.				
Form and Size	Short, slender rods, 1.4 × 0.5μ		Short, slender rods, 1.3 x 0.45μ	Short, slender rods, 1.2 x 0.5μ
Gram and Acid-fast tests	Negative		Negative	Negative
Flagella	Single polar	Motile in young culture	Single polar	Single polar
Capsules and Chains	Present		Present	Present
Spores	Not found		Not found	Not found
Chromogenicity (in cultures 2 to 24 days old)	From Naphtalene or Straw Yellow to Barium, Wax, Naples and Mustard Yellow	Primuline Yellow on potato blocks, flowing off as a yellow slime.	From Naphthalene or Amber Yellow to Wax and Primuline Yellow.	From Naphthalene Yellow to Marguerite and Amber Yellow.
CULTURAL CHARACTERS AND PHYSIOLOGICAL REACTIONS.				
Agar Stroke	Abundant growth, glistening, running down slant as a thick, viscid slime		Abundanr growth, glistening running down slant as a thick, viscid slime.	Abundant growth, glistening, rnnning down slant as a feebly sticky slime.
Agar colonies	Circular, smooth surface, entire, convex, translucent, coarsely granular		Circular, smooth surface, entire, convex, translucent coarsely granular.	Circular, smooth surface, entire, convex, translucent, coarsely granular to grumose.
Gelatine stab: Growth	Slow, best at top	Moderate	Slow, best at top	Slow, best at top
Line of puncture	Filiform		Filiform	Filiform
Liquefaction	Crateriform	Slow liquefaction	Crateriform	Crateriform
Nutrient broth : Clouding	Slight		Slight	Slight
Surface growth	None		None	Light rim
Sediment	Viscid		Viscid	Flaky
Odour	None		None	None
Action on Glucose, Sucrose, Lactose	Neither acid nor gas		Neither acid nor gas	Neither acid nor gas
Action on Milk				
Skimmed Milk	Soft, viscid clot, slowly peptonized. No gas, Yellow pellicle, rim and sediment. No odour.	Bulky curd, with slow clearing. Yellow deposit. Strongly alkaline after three months.	Soft viscid clot, slowly peptonized. No gas. Yellow pellicle rim and sediment. No odour.	Soft viscid clot, very slowly peptonized. No gas. Yellow pellicle, rim and sediment. No odour.
Litmus Milk	Litmus reduced, colour restored after three months	Gradual reduction of the litmus.	Litmus reduced, colour restored after three months.	Litmus reduced, colour restored after three months.
B. C. P. Milk	Reaction Strongly alkaline		Reaction strongly alkaline	Reaction strongly alkaline
Relation to Free Oxygen	Strict ærobe		Strict aerobe	Strict aerobe
Production of :—				
Indole	Negative		Negative	Negative
Hydrogen Sulphide	Negative		Negative	Negative
Ammonia	Positive		Positive	Positive
Action on nitrates	No nitrite or gas found		No nitrite or gas found	No nitrate or gas found
Action on Starch	Hydrolysed	Little evidence of diastatic activity (?)	Hydrolysed	Hydrolysed
Thermal Death-point	50—51 °C		50—51 °C	50—51 °C

	Medium in young animals	

Oxygen requirements. These were determined by growth on agar in Buchner tubes and also by growth in broth under a layer of oil Nujol).

The indol test. The production of indol was determined by the Ehrlich technique, with cultures in Peptone solution, tested after 4, 11, 13 and 29 days.

Cultures were also tested after 29 days by running down the sides of the tubes about 1 c.c. of concentrated sulphuric acid ; no pink or red colour was formed after several minutes. A few drops of a very dilute solution of sodium nitrite were then added to the tubes and these left for about half an hour. No red coloration was observed at the junction of the liquids.

In another experiment, cultures were made in 0.1% Bacto-Tryptone solution. After 11 days, growth in some tubes had not been very good, but a pronounced cloudiness had nevertheless resulted ; in the other cultures growth had been better and a deposit had formed at the bottom of the tubes. Tested by the Ehrlich-Böhne technique, both with and without ether, no indol was found.

Nitrate reduction. Inoculations were effected in tubes of Peptone nitrate solution on one occasion and of nutrient broth containing 0.1% of, potassium nitrate (A.R.) on another. The culture tubes were fitted with Durham's tubes. Sulphanilic acid and alpha-naphthylamine, both in acetic acid, added to the culture tubes at intervals of several days failed to reveal the presence of nitrite.

Each time the cultures were tested, a small quantity of zinc dust was afterwards added to the tubes. A pronounced red coloration showed that the nitrate had not been used up.

Ammonia production. The following were the investigations carried out :—

The addition, in 1935, of Nessler's reagent to 7 - day old cultures of the palm bacterium in nutrient broth had indicated the formation of ammonia. The reagent was added directly to the culture tubes, but as the medium itself produced a yellowish-green precipitate in the control tubes, another experiment was carried out where a liquid culture, after about two months growth, was distilled with magnesium oxide and the distillate tested for ammonia. With the control distillate, a faint brownish coloration was produced, but with the culture distillate, each drop of the reagent added produced a precipitate, the liquid finally becoming completely opaque.

In 1939, a volumetric determination of the quantity of ammonia pro-

duced in culture by *B. vasculorum* from cane, palm and Thysauolæna was carried out by the aeration method (9).

For this purpose, 100 c.c. of Beef extract broth was poured in each of 4 Erlenmeyer flasks and sterilized in the autoclave. Three flasks were inoculated and one kept as control; they were placed together and left at room temperature for fifteen days. The ammonia was then caused to be liberated by slow aeration during two hours, after the addition of just sufficient saturated sodium carbonate solution to render the liquid alkaline. The gas was absorbed by $\frac{N}{25}$ Sulphuric acid and the acid used up was determined by titration with $\frac{N}{25}$ caustic soda solution. This was as follows for the control and for the three bacteria in the order named above respectively: 1.1, 3.7, 14.5 and 8.2 cc. The acid neutralized by the ammonia produced by the three organisms, may therefore be taken as 2.6, 13.4 and 7.1 c.c. respectively. The ammonia produced was therefore 0.018, 0.091 and 0.048 grams per litre respectively. Under the conditions of the experiment, the three isolates therefore produced ammonia in the ratio of 1 : 5 : 3 aproximately.

Action on Starch. On 11/9/37 the three isolates were stroked across the surface of starch agar plates, in duplicate cultures. One dish of each culture was tested with Lugol's iodine solution on 14/9/37 and the other on 17/9/37, the width of the cleared zone being measured in each case. The results are tabulated below :

TABLE II

	Width of clear zone in cms	
	on 14.9.37	on 17.9.37
B. vasculorum from cane	1.3	2.7
„ „ palm	1.8	2.1
„ „ Thysanolæna	0.6	1.5

Another test in duplicate tubes of starch broth was carried out in September 1938. Portions of the cultures from the tubes were tested after 2, 19, 29 and 73 days with the following results :

TABLE III

	Hydrolysis after			
	2 days	19 days	29 days	73 days
The cane pathogen	evident	complete		
The palm pathogen	evident	complete		
The Thysanolæna pathogen	none	partial	partial	complete

The palm pathogen, therefore, is as active as *B. vasculorum* from cane in hydrolysing starch, but the Thysanolæna bacterium is much slower than the other two in this respect.

Milk reactions. These were studied at room temperature. In one investigation, three isolates of the Thysanolæna pathogen, cultures TS_{11}, TG_{32} and TL_{82}, studied concurrently with the cane and palm bacteria, cultures GA and PA respectively, proved to be at first more active than the latter two in peptonizing milk. Clearing by the three isolates started on the 4th day, whereas GA and PA began clearing only on the 23rd day. After 70 days, however, about half of the milk remaining in the GA and PA tubes had been cleared, compared to only about 1/9th of that of the Thysanolæna cultures. The remainder of the milk was translucent to varying degrees in all the cultures, but the T cultures were always more opaque than the others. The clot produced was very soft and only noticeable by the undigested part not yielding readily to inclination of the tubes.

In two other similar investigations, the clearing was such that the writer feels justified to state that the Thysanolæna organism peptonises milk more slowly than do the cane and palm pathogens. In one of these researches, of which a photograph of the tubes is shown in Plate VII 35, after the experiment had been in progress for 83 days, the following measurements were obtained :—

PLATE VII

Photo. 35 — Milk reactions of *B. vasculorum* cultures after 83 days. (Bacto-milk media).

GD from sugar cane,
PL_{61} from palm
TS_{11} from Thysanolæna

(Plate Ilford S.R. Panchro., Filter Wratten "F", Transmitted light.)

Phots. 36, 37, 38 — Photomicrographs of *B. vasculorum* from cane, palm and Thysanolæna respectively (cultures GD, PA and TS_{11}) ; x 700. Stain C. Fuchsin ; Plate Ilford S.R. Panchro. ; no filter.

Phot. 39 — Photomicrograph of *B. vasculorum* from cane, (culture GD), showing flagella. x 700. Stain : Gray's method.

Phots. 40 & 41 — Photomicrographs of *B. vasculorum* from palm (culture PA), showing flagella. x 700. A clump of bacterial cells is shown in phot. 41. Stain. Gray's method.

Phot. 42 — Photomicrograph of *B. vasculorum* from Thysanolæna (culture TS_{11}). Showing flagella. x 700.

PLATE VII.

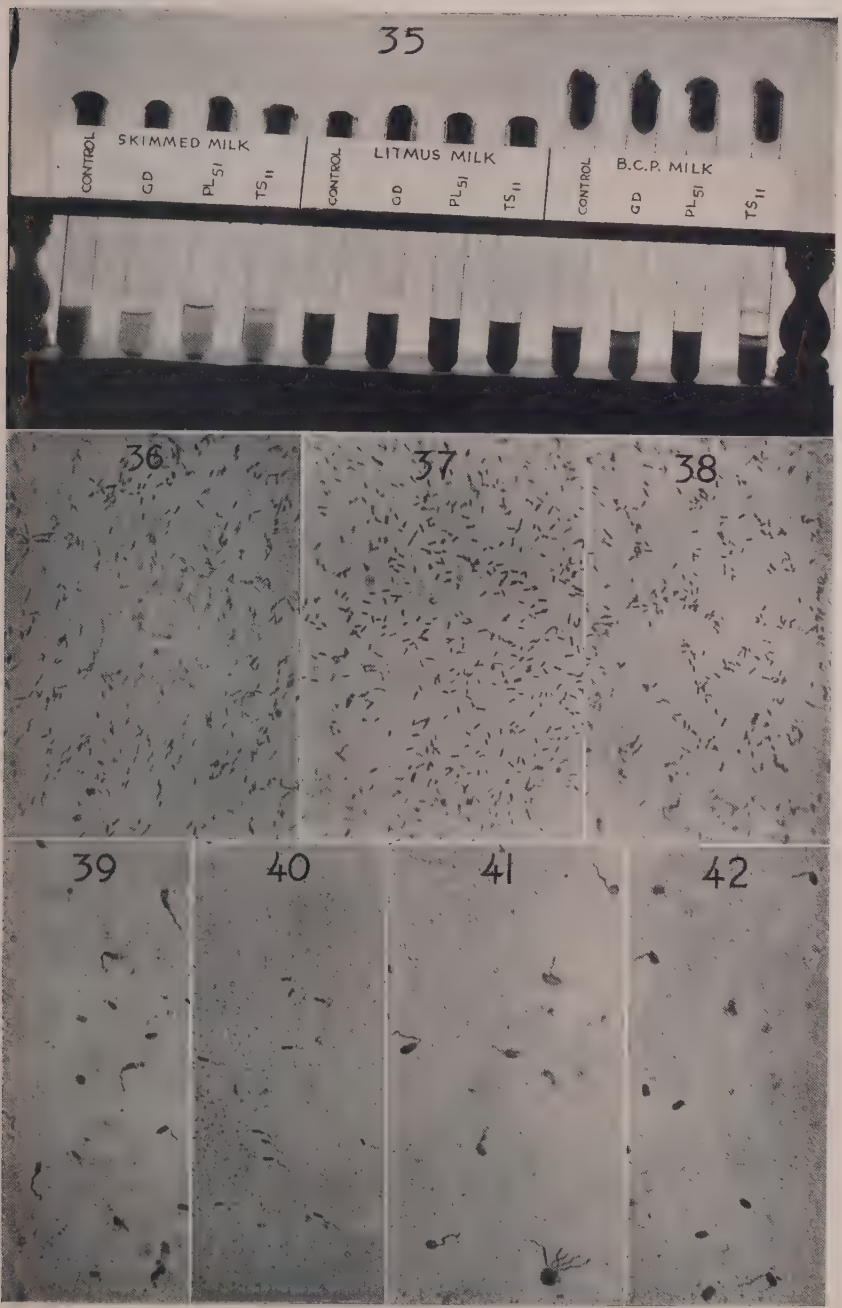

35
CONTROL
SKIMMED MILK
GD
PL 51
TS 11
CONTROL
LITMUS MILK
GD
PL 51
TS 11
CONTROL
B.C.P. MILK
GD
PL 51
TS 11
36
37
38
39
40
41
42

TABLE IV

SKIMMED MILK

	A Original amount of milk mm.	B Amount milk left mm.	C Amount clot undigested mm	D Amount medium cleared mm
Control	46	29	nil	nil
GD	46	25	nil	46
PL_{51}	46	34	17	29
TS_{11}	50	34	25	25

	LITMUS MILK				B.C.P. MILK			
	A	B	C	D	A	B	C	D
Control	50	29	nil	nil	42	29	nil	nil
GD	50	34	25	25	2	29	17	25
PL_{51}	50	34	17	33	42	29	13	29
TS_{11}	46	29	25	21	42	29	25	27

Mean	A	B	C	D	$\frac{D}{A}$ $\left(=\frac{A-C}{A}\right)$	$\frac{C}{A}$	$\frac{B-C}{B}$	$\frac{C}{B}$
GD	46	29	14	32	0.70	0.30	0.520	.48
PL_{51}	46	32	16	30	0.65	0.35	0.50	0.50
TS_{11}	46	31	25	21	0.54	0.46	0.19	0.81

With all three cultures, clearing in this instance started on the 2nd day, and the photograph referred to will show that the rate of clarification effected by the T - culture was much slower than that by the G - and P - organisms. Even after 113 days, the T - cultures had not completely cleared.

The above figures do not purport to indicate the absolute rates of clearing brought about by the three isolates. The results vary somewhat with different batches of milk, under different conditions of temperature, and even in the duplicate tubes of the same batch of milk. The above ratios may be taken however to indicate the conditions occurring after the cultures have been growing for some time.

The colour finally produced in the different milks indicates more forcibly a difference between the T - organism on the one hand and the G - and P - organisms on the other :—

TABLE V

Colour by Transmitted light after 113 days.			
	Skimmed Milk	Litmus milk	B.C.P. Milk
Control	Ivory Yellow	Purplish Lilac	Deep Olive Buff
GD	Cinnamon rufus	Vernonia purple	Pansy purple
$PL_{5\,1}$	Kaiser Brown	Corinthian purple	Bordeaux
$TS_{1\,1}$	Cream buff	Lobelia violet	Argyle purple

Conclusion.

The characters and reactions shown by the isolates from the different hosts discovered indicate that the Thysanolæna pathogen belongs to a strain of *Bacterium vasculorum* slightly different from that isolated from the sugar cane, the Dictosperma palm and probably also from that of maize.

References

(1) Bell, A.F. : " Thirty sixth Annual Report of the Bureau of Experiment Stations ", Queensland, p. 26, 1936.

(2) Earle, F.S. : Sugar cane and its culture, p. 157. New York, 1928.

(3) Hughes, C.G. : " Alternate Hosts of Bacterium vasculorum ". Proceedings International Society Sugar Cane Technologists, VIth Congress, Baton Rouge La., pp. 430-437, 1938.

(4) — : " Alternate Hosts of *B. vasculorum*, the causal agent of Gumming Disease of Sugar Cane ". Bureau of Sugar Expt. Stations, Queensland. Tech. Communication No. 3, 1939.

(5) Ivanoff, S.S. : " Studies on the Host range of *Phytomonas stewarti* and *P. vasculorum.* " Phytopathology, 25, 992-1002, 1935.

(6) " Manual of methods for Pure Culture Study of Bacteria. Committee on Bact. Technique of the Soc. of Amer. Bacteriologists — Geneva. N. Y.

(7) North, D.S. : " The Gumming Disease of the Sugar Cane, Its Dissemination and Control. " Agr. Rept. No. 10 (Technical) — The Colonial Sugar Refining Co. Ld., Sydney, 1935.

(8) O'Connor, C. A. : Annual Report of the Dept. of Agriculture, Mauritius, p. 11, 1937.

(9) " Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, " 4th. Ed. Association of Official Agricultural Chemists, Washington, D.C.

(10) Orian, G. : " Le " Bitten-Leaf disease " du Cocotier. " La Revue Agricole de l'Ile Maurice, No. 38, pp. 86-87, 1928.

(11) — : " Notes préliminaires sur une maladie du Palmier à Maurice, causée par le *Bacterium vasculorum* (Cobb) Gr. Smith. La Revue Agricole de l'Ile Maurice, No. 93, pp. 100-101, 1937.

(12) — : " Un nouvel hôte naturel du *Bacterium vasculorum* (Cobb) Gr. Smith, à Maurice. " La Revue Agricole de l'Ile Maurice, No. 94, pp. 130-131, 1937.

(13) — : " Natural Hosts of *Bacterium vasculorum* (Cobb) Gr. Smith in Mauritius. " Proceedings International Society Sugar Cane Technologists, VIth. Congress, Baton Rouge, La., pp. 437-447, 1938,* (Published 1939).

* An appendix to that paper on pp. 446-447 contains a brief reference to some of the artificial hosts of *B. vasculorum* found in Mauritius.

(14) Orian, G. : " Annual Report of The Department of Agriculture ", Mauritius, pp. 35-37, 1937.

(15) — : Note on " Recent Developments in Sugar cane Pathology in Mauritius, " in article by Tims, E.C. Proceedings Int. Soc. Sugar Cane Technologists, VIth Congress, Baton Rouge La., p. 216, 1938.

(16) Ridgway, R. " Color Standards and Color Nomenclature " Washington, D.C., 1912.

(17) Shepherd, E.F.S. : " Annual Report of the Department of Agriculture, " Mauritius, p. 37, 1932.

(18) — : " Annual Report of the Department of Agriculture, Mauritius ", p. 20, 1934.

(19) — : " Annual Report of the Department of Agriculture Mauritius, " p. 26, 1935.

Résumé.

Jusqu'à tout récemment la maladie de la gomme causée par le *Bactérium vasculorum* n'était connue que sur la canne à sucre seule.

En 1932, l'auteur étudia une maladie du maïs caractérisée par la production de bandes décolorées sur les feuilles et par une exsudation de gomme par la tige coupée. Des tissus malades, une bactérie fut obtenue qui fut prouvée être l'agent causal de la maladie, mais dont l'identité ne fut pas complètement établie. Les faits mis en avant, toutefois, suffisent à prouver amplement que cette bactérie était le *Bactérium vasculorum*. C'était donc la première fois que le pathogène de la maladie de la gomme était trouvé sur une plante autre que la canne à sucre.

Une maladie bactérienne du palmiste blanc, *Dictyosperma album* Wendl. et Drude et une autre du bambou balai *Thysanolæna maxima* Kuntze furent étudiées de 1934 à 1937 et furent aussi trouvées être causées par le *Bacterium vasculorum* ; trois plantes agissent donc à Maurice comme hôtes naturels de cette bactérie. L'importance économique de ces découvertes est brièvement discutée.

Les recherches de l'auteur ont aussi prouvé que les plantes suivantes peuvent contracter la maladie artificiellement après inoculation avec le *B. vasculorum :* le collier cipaye ou Larmes de Job, la Fataque, le gros bambou commun et le cocotier. Mention est aussi faite des travaux de S.S. Ivanoff en Amérique en 1934 et de C. G. Hughes en Australie de 1935 à 1938, sur les hôtes artificiels de la bactérie.

Les caractères des différentes cultures étudiées sont aussi données.

LA LUTTE CONTRE LES TERMITES A MAURICE ET L'APPLICATION DE L'ARSENIC POUR COMBATTRE CES INSECTES

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Il est bien connu que les Termites (Carias) sont les plus grands ennemis des bâtiments et constructions en bois. Moutia* a mis en lumière la biologie de ces insectes et les méthodes de lutte adoptées pour les détruire à Maurice. Les dommages qu'ils causent sont d'un ordre assez considérable et bien souvent on décèle leur présence lorsqu'ils ont presque terminé leur œuvre destructrice.

L'arsenic sous une forme ou une autre a de tout temps été reconnu, dans la lutte contre les termites, comme étant un insecticide alimentaire par excellence. Il semblerait cependant qu'on aurait hésité à employer des arsenicaux solubles à haute dose.

C'est au début d'avril 1940 que nous avons commencé la préparation d'une mixture d'insecticides dont le principe actif est l'anhydride arsénieux, As_2O_3, ou " Arsenic ". En augmentant la proportion d'arsenic dans la mixture de 10 à 40 o/o, nous avons constaté une augmentation progressive du taux de mortalité qui s'est élevé finalement à 100 o/o. La composition ultime de la poudre est la suivante :

Anhydride Arsénieux, As_2O_3	40
Antimoniate de Potasse	5
Borax	2
Rouge de Bijoutier (Sesquioxyde de Fer, Fe_2O_3)	53
	100

L'oxyde de fer est un diluant inerte, l'antimoine et le borax sont tous deux toxiques aux termites, mais l'insecticide principal reste bien l'arsenic.

* 1936, Moutia, A. Termites in Mauritius, Bull. No. 21, Scien. Ser., Dept. of. Agric., Mauritius.

Nous recommandons que les ingrédients soient pulvérisés et bien mélangés, car le succès dépend du pouvoir adhérent de la poudre, donc, de la grosseur des particules ; à ce point de vue les particules devront passer au tamis de 100. La poudre doit être bien sèche et devra toujours être conservée dans un logement bien sec, car l'humidité la rendrait inefficace en provoquant une agglomération des particules.

La base du traitement par les poudres consiste à insuffler une petite quantité de poudre très fine dans les galeries ou dans le nid où les termites se trouveront alors en contact avec le poison. Si l'on réussit à obtenir une grande distribution du poison par le mode d'application, le traitement sera très efficace. Les insectes aideront à la contamination totale de la colonie en véhiculant l'insecticide non seulement dans les différentes galeries, mais aussi dans les cellules les plus profondes du nid. Le résultat final sera la destruction complète de la colonie.

L'application de la poudre se fait par beau temps dans les galeries ou dans le nid, si ce dernier est accessible, au moyen d'un puissant pulvérisateur. Si l'opérateur ne peut se procurer un soufflet, il pourra facilement se munir d'une poire d'auto pourvue d'une tige métallique (1 pied de long environ) à ouverture modérée (1-2 mm. de diamètre). La poudre est introduite dans la poire ; on visse le tube métallique et par simple pression intermittente l'insufflation se fait dans les galeries ou dans le nid — autant que possible sur les individus de la colonie. Les résultats obtenus ont été des plus satisfaisants, car au bout de 3 à 4 jours le taux de mortalité s'est élevé à 100 o/o. Une application (5 à 10 grammes de poudre environ) suffit généralement, mais s'il est nécessaire on pourrait répéter une deuxième après 10 jours.

L'insecticide que nous recommandons peut être employé contre la plupart des termites connus ici et principalement contre :—

(a) *Kalotermes (Cryptotermes) pallidus* Ramb., espèce nidifiant dans le bois de construction.

(b) *Coptotermes* sp. et *Heterotermes philippinensis* Light, espèces nidifiant dans le sol, mais formant des galeries aériennes.

(c) *Nasutitermes Valtzkowi* Waam., espèce nidifiant sur les arbres et dans les maisons.

(a) *Kalotermes (Cryptotermes) pallidus* Ramb.

Ce *Kalotermes* se rencontre le plus souvent dans le bois de construction, les meubles, les encadrements, etc... Son nid consiste en des galeries longitudinales creusées à l'intérieur du bois, communiquant à l'extérieur par de petits orifices d'où les excréments, sous forme de granules, tombent

au sol. Cette espèce est bien la plus difficile à détruire étant donné sa méthode de former plusieurs nids dans le même bois. Ici le meuble ou bois attaqué devra subir plusieurs traitements dans des orifices différents. L'arsenic étant un poison violent très soluble, tout meuble traité devra donc être exposé en plein air, à l'action du soleil, à plusieurs reprises.

(b) *Coptotermes* sp et *Heterotermes philippinensis* Light.

Le *Coptotermes* construit son nid dans le bois qui se trouve en contact avec le sol. L'*Heterotermes philippinensis* nidifie dans le sol. Ces deux espèces construisent des galeries aériennes. Le traitement dans ces cas se fera dans les galeries.

(c) *Nasutitermes Vœltzkowi* Wasm.

Le *Nasutitermes Vœltzkowi* est bien le plus facile à détruire car chez cette espèce le nid et les galeries sont accessibles. Nos expériences ont démontré que lorsqu'on traite directement le nid, la mortalité s'élève à 100 o/o au bout du troisième jour. Par contre, lorsque la poudre est insufflée rien que dans les galeries, ce n'est qu'au bout du cinquième jour que la colonie est détruite.

QUELQUES NOTES SUR UNE CANNE SAUVAGE NATURALISÉE A MAURICE.

Dans une récente étude que vient de faire paraître la Station de Recherche sur la Canne à Sucre (Bulletin No. 17, 1940) Monsieur G. C. Stevenson dévoile l'origine probable de la Uba Marot. Cette variété serait selon lui une hybride naturelle d'une canne sauvage naturalisée à Maurice et d'une canne "noble" quelconque. En présence de cette importante découverte nous croyons que ces notes offriront un certain intérêt.

La *Saccharum spontaneum* naturalisée à Maurice fut trouvée pour la première fois croissant le long des berges de la Rivière Sèche — dans les environs de Trou d'Eau Douce — en Juillet 1938. C'était l'époque de la floraison et les panaches argentés de cette plante frappèrent de suite par leur ressemblance avec ceux de la canne à sucre. Nous n'avions alors rencontré cette graminée nulle part dans l'île. Des spécimens furent prélevés et conservés dans l'herbier du Département d'Agriculture alors qu'un duplicata était envoyé à Kew aux fins d'identification. Les autorités de l'herbier de Kew confirmerent l'identification de cette plante comme étant une forme de *Saccharum spontaneum* Linn.

Par la suite nous avons rencontré cette canne sauvage dans de nombreux endroits de l'île : aux environs de Bell Village, d'Abercrombie, à Bassin, à Quartier Militaire à Constance Manès à Bois Chéri et ailleurs. Bien que préférant les endroits marécageux, cette plante se développe également dans les endroits secs et produit alors des touffes de plusieurs pieds de haut ressemblant quelque peu au vétivert mais avec des feuilles plus larges et d'un vert plus clair. Dans de nombreux cas des touffes de cette canne furent observées dans les environs des temples indiens ou des "kalimayes" que l'on rencontre un peu partout le long des routes. Les vieux indiens que nous avons questionnés à cet effet n'ont jamais pu nous éclairer quand à l'origine exacte de cette plante mais l'ont invariablement appelé "ène qualité vétivert". C'est à leurs yeux une plante sacrée dont les feuilles coupées en morceaux d'environ six pouces de long et liées en bottes servent à certaines cérémonies religieuses notamment à celle du "Cavadee" nous dit on.

Il semblerait donc que cette plante nous arriva de l'Inde avec les immigrants, à une époque qu'il est difficile d'établir exactement mais assez éloignée cependant, en raison même de la nature sacrée de la plante et du fait de sa distribution dans l'île. Elle avait toutefois, pour une raison ou pour une autre passé inaperçue des botanistes jusqu'ici.

Il est intéressant de faire ressortir que dans le cours de son étude Monsieur Stevenson (loc. cit.) démontre que cette canne sauvage est incontestablement du type Indien de Coimbatore ayant le même nombre de chromosomes somatique que cette dernière (64) et différent de celle de la canne sauvage de Java qui en a 112.

P. O. W.

LA CONSERVATION DES DENRÉES ALIMENTAIRES DANS L'EMPIRE COLONIAL*

(Suite)

Les Pestes et leur Contrôle

(Les Insectes s'attaquant aux Grains et aux Farines)

Les grains et les farines sont sujets aux attaques de nombre d'insectes. Parmi, on trouve :

(a) Les calandres, insectes caractérisés par un long appendice buccal, telles la *Calandra granaria* et la *Calandra oryzae*. Les femelles peuvent vivre 4 à 5 mois, pondent chacune environ 100 à 200 œufs, desquels éclosent autant de larves qui tout de suit se mettent à attaquer le grain. Le stade larvaire se passe à l'intérieur du grain qui est entièrement vidé au moment où la larve a terminé son développement. Le cycle évolutif et la longévité de ces insectes se prolongent d'autant plus que la température est basse. Ils sont aussi influencés par les conditions d'humidité et par la nature du grain.

(b) Le "*Saw-toothed Grain Beetle*" (*Silvanus surinamensis*) qui tient son nom de la présence de dentelures sur les côtés latéraux du thorax. Les larves et les adultes se nourrissent de farines, de noix et de grains de différentes sortes.

(c) Le scarabée des farines (*Tribolium sp.*), qui se trouve souvent associé aux calandres dans le grain déjà endommagé par ces derniers, mais on le trouve plus communément s'attaquant aux farines. Il diffère des charançons en ce qu'il est dépourvu de rostre, qu'il est de couleur plus claire et qu'il est plus plat. Sa larve ne se loge pas dans le grain comme les calandres, mais erre librement dans la masse, L'évolution de cet insecte à partir de l'œuf jusqu'au stade adulte couvre une période d'environ 40 jours.

(d) Les bruches, appartenant au genre *Bruchus*, ont un corps raccourci, un rostre épais et des antennes proéminentes. Les larves sont courtes et grosses et se développent à l'intérieur des pois et des fèves. Les œufs sont déposés sur le grain d'où les larves qui en éclosent le pénètrent.

Un certain nombre de papillons attaquent aussi le grain et les farines dont parmi on trouve dans les tropiques différents genres d'*Ephestia* et d'autres tels le papillon du cacao, etc. Ils n'occupent pas la même importance que les charançons, mais si l'on ne prend pas soin d'empêcher leur invasion, ils peuvent causer d'importants dommages.

* Mémoire préparé par les Conseillers Agricoles auprès du Secrétaire d'Etat. (Traduction).

Il y a encore les mites qui, sans être trop apparentes, s'attaquent aux grains et aux autres denrées alimentaires en causant quelques fois beaucoup de dommages.

Comment les Insectes Infestent les Produits Emmagasinés

L'infestation des produits emmagasinés par les insectes a lieu soit avant l'emmagasinage, c'est-à-dire, aux champs ou au cours des opérations précédant l'emmagasinage; soit pendant leur séjour dans des magasins déjà infestés. L'infestation aux champs a lieu généralement par les bruches. On a aussi observé que l'infestation du cacao par les pyrales avaient lieu lorsque les grains sont répandus dans les granges pour être séchés. Les papillons viennent y déposer leurs œufs pendant la nuit (6). Ce genre d'infestation, si elle ne peut être complètement évitée, peut être cependant réduite dans une grande mesure.

Il a été établi en Rhodésie du Sud que le maïs était attaqué aux champs par des calandres qui proviennent des différentes sources se trouvant sur la ferme même, telles que les granges, les remises, etc. Les magasins sont ensuite infestés par le grain contaminé aux champs. Avec une telle prédisposition à l'infestation aux champs, l'on comprend aisément qu'à leur tour, les greniers soient infestés et que les produits qui y seront placés soient menacés si les précautions voulues ne sont pas prises. L'importance de la propreté des granges et des bâtiments avoisinant les magasins afin d'éviter leur infestation par les insectes qui y seraient hébergés, ne saurait donc être trop recommandée.

Les Précautions contre l'Infestation.

Le grillage des portes et des fenêtres peut être très utile contre l'invasion des pestes, tandis qu'un bon éclairage, une parfaite ventilation et une température relativement basse sont aussi des facteurs importants étant donné que les teignes et les calandres se développent le mieux dans l'obscurité et dans une atmosphère calme et tiède. Les magasins doivent être régulièrement vidés et bien nettoyés au moins une fois par an. Toutes les barriques vides, les sacs et autres récipients déjà employés devront être stérilisés avant qu'ils ne servent de nouveau. La stérilisation peut s'effectuer au moyen d'air chaud, d'eau bouillante ou par exposition au soleil. Les magasins peuvent être désinfectés par la pulvérisation ou le lavage des murs avec une émulsion de pétrole, de carbinoleum dilué ou d'autres désinfectants. Le chaulage des murs et des autres parties du bâtiment doit se faire régulièrement parce qu'il aide à déceler toute saleté de même que la présence d'insectes destructeurs. Tous les débris et les balayures provenant du magasin doivent être brûlés, principalement ceux se trouvant sous le fardage sur lequel les sacs sont empilés. La rotation régulière des produits emmagasinés permet de controler la propagation des insectes. Les produits indemmes ne doivent jamais être emmagasinés

avec ceux infestés ou dans des bâtiments ou des récipients qui n'auraient pas été scrupuleusement nettoyés et désinfectés. Dans le cas où les magasins deviendraient tellement envahis et qu'il serait impossible de les débarrasser complètement, il est préférable de les brûler.

Lorsque le grain doit être emmagasiné en grande quantité pour un temps assez long, il est prudent de le cribler dès sa réception afin de le débarrasser des charançons avant que ces derniers ne se multiplient. Plus le criblage sera différé, plus l'infestation sera intense.

L'infestation des denrées par les insectes pendant l'emmagasinage représente un problème qui s'offre sous deux aspects différents : l'un étant l'infestation par l'introduction de grains déjà contaminés, par ce que l'on pourrait appeler la "population importée" ; l'autre étant l'infestation par la population résidente même du local. En général, la destruction de la population importée peut être plus facilement assurée que celle de la population résidente. Les denrées peuvent à leur réception être traitées, si nécessaire, dans des récipients spéciaux, tandis que les magasins, en raison de leur structure et de leur pouvoir presqu'illimité d'abriter les insectes, sont plus difficiles à nettoyer. Il arrive souvent que la fumigation des produits à leur arrivée les débarrasse complètement des insectes, mais cela ne suffit pas au nettoyage des magasins ou des entrepôts que l'on doit asperger de solutions insecticides. A ce propos, les précautions élémentaires suivantes doivent être prises pour empêcher l'infestation de s'étendre :

(1) Les produits infestés doivent être isolés. Les récipients tels que les sacs, paniers, barriques, etc. ayant servi à transporter des produits infestés doivent être désinfectés ou stérilisés avant de reservir.

(2) Les débris et balayures sont particulièrement suceptibles d'être infestés. Ils devront être mis à l'écart pour être stérilisés ou brûlés au plus tôt. Dans aucun cas, les balayures ne devront être retournées au magasin.

(3) Les nouvelles récoltes ne doivent jamais être emmagasinées avec celles des années précédentes à moins que l'on soit certain que ces dernières sont indemmes.

(4) En vérifiant les produits quant à la présence d'insectes, une attention toute spéciale doit être apportée aux endroits suivants :

(a) entre les sacs ou les paniers adjacents

(b) entre ceux-ci et les murs du bâtiment

(c) dans les oreilles et les replis des sacs et dans le treillage des couvercles et des fonds des paniers

(d) dans les endroits les plus sombres et les plus élevés

(e) sur le parquet et plus spécialement sur les murs des bâtiments dans le voisinage de produits infestés

(f) dans le fond des charrettes, des wagons et des autres engins servant à la récolte.

Les insectes et les teignes se multiplient seulement lorsque leur nourriture et leur lieu de propagation ne sont pas bouleversés. Il est donc évident que les amoncellements de vieux grains, de farines, de balayures, les vieux sacs, les débris accumulés et les fissures dans le parquet sont des lieux favorables à leur développement. La première action à prendre en faisant la guerre à ces pestes est donc la destruction de tous ces nids d'insectes qui sont autant de foyers d'infection.

La Lutte contre les Insectes

Les principaux moyens disponibles pour la protection des denrées alimentaires emmagasinées contre les insectes sont la fumigation, l'emploi de poudres insecticides et peut-être aussi celui de substances collantes.

La Fumigation

Malgré la fumigation extensive pratiquée dans certains pays, les principes fondamentaux en sont jusqu'à présent insuffisamment connus. C'est pourquoi le "*Department of Scientific and Industrial Research*" a cru nécessaire de préparer un ouvrage traitant des principes de la fumigation, duquel nous avons obtenu avant sa publication, les renseignements que nous donnons ci-dessous avec l'autorisation de ce Département (11).

La fumigation nécessite comme première condition l'évaporation complète de la substance fumigatoire. Ceci n'offre cependant aucune difficulté dans les pays chauds. La principale cause d'insuccès réside surtout dans l'énorme quantité de gaz qui est absorbé et qui est ainsi rendu inactif. Cette absorption a lieu par les cloisons mêmes de l'appareil fumigatoire, à la surface des sacs, des récipients et des denrées elles-mêmes. En conséquence, une quantité suffisante de substance fumigatoire doit être allouée à l'absorption et doit être considérée comme n'ayant aucune action insecticide. En raison du pouvoir absorbant des produits emmagasinés, la concentration des vapeurs fumigatoires diminue en proportion de la profondeur de la masse de ces produits. La diffusion dans les couches inférieures ne dépendant donc pas seulement du fait que ces vapeurs soient plus lourdes que l'air, il est essentiel d'appliquer une dose suffisamment forte pouvant produire des vapeurs à une concentration toxique après que le produit en soit complètement saturé. L'absorption des vapeurs

par les denrées diffère selon la nature de celles-ci. Par exemple, celles riches en matières grasses en absorbent une grande proportion, tandis que les produits secs et les grains n'en absorbent que très peu. En conséquence, l'aération des produits oléagineux après la fumigation devra être plus longue. La diffusion des vapeurs dans la masse des produits étant en fonction de leur concentration et de la durée du traitement, une faible dose de longue durée aura donc le même effet qu'une dose plus forte appliquée pendant une période proportionellement plus courte.

Une autre cause d'insuccès dans la fumigation provient de la façon dont les sacs contenant les denrées sont empilés Il est important qu'ils le soient de telle sorte qu'ils offrent le plus de surface possible aux vapeurs insecticide. On a trouvé, au cours d'expériences faites avec le cacao, qu'une extrémité de chaque sac doit être exposée. La pénétration des vapeurs insecticides est aussi affectée par l'espace qui existe entre les grains. Cet espace varie beaucoup avec les différents produits et atteignent souvent des proportions énormes. La diffusion et la circulation effective des vapeurs insecticides peuvent être aidées par des moyens relativement simples tels qu'un panka suspendu au toit et mû du dehors par une corde.

En général, le point important à observer est d'assurer par une dose appropriée une circulation effective des vapeurs à travers toute la masse des produits à désinfecter en tenant compte de l'absorption et des autres pertes qui ont souvent lieu.

Un désavantage attaché à ce traitement consiste en la rétention des vapeurs par les produits fumigés. Cela exige une assez longue aération des denrées avant qu'elles ne puissent être consommées ou apprêtées. Mais il ne constitue pas un très sérieux inconvénient ; même lorsqu'on emploi le cyanure d'hydrogène qui est un gaz des plus pénétrants, il suffit seulement d'aérer les produits traités pour en éliminer toutes les vapeurs.

Certaines denrées pourtant ne peuvent supporter la fumigation, notamment celles riches en huiles essentielles, telles que le girofle. Mais à part quelques exceptions, une aération bien faite suffit à débarrasser les produits des vapeurs qu'ils ont absorbées.

(A suivre)

LE JARDIN EN MARS ET AVRIL

La Préparation des Caisses de Semis.

Avec la saison des semis qui approche nous espérons que les conseils pratiques qui suivent seront lus avec intérêt :

1o. Les semis doivent être protégés contre les pluies et exposés au soleil couchant.

2o. Des récipients en ferblanc doivent être préférés aux " caisses de pétrole ". Ils sont plus maniables et offrent une barrière naturelle aux attaques des limaçes et des colimaçons.

3o. Si l'on veut éviter les attaques des champignons causant la " fonte " des semis, le drainage des " caisses " devra être parfait ; ainsi le fonds du ferblanc devra être percé de nombreux trous d'environ 1/4 de pouce et rempli de gravier jusqu'au tiers de la hauteur des parois.

4o. La terre devant servir aux semis doit être tamisée, contenir une forte proportion de sable, un peu de charbon pulvérisé et du fumier fin.

5o. Pour éviter les parasites : insectes et champignons l'on doit brûler le compost en remuant la masse plusieurs fois avant d'en remplir les caisses.

6o. Avant de faire le semis proprement dit la terre doit être mouillée complètement. Ceci permet a l'eau d'arrosage de s'écouler rapidement au lieu de saturer seulement la zone supérieure.

7o. L'on ne doit pas semer les graines trop près les unes des autres ou trop profondément.

8o. L'arrosage doit être fait au moyen d'un arrosoir à pomme très fine. Un excés d'eau est aussi mauvais que de laisser la terre se dessécher.

9o. Environ une semaine après le semis, les caisses doivent être arrosées avec du " Chesthunt Compound* " : composé ayant des propriétés nutritives et fongicides.

*Préparation du « Chesthunt Compound »

Faire broyer dans un mortier en porcelaine onze parties de Carbonate d'Ammoniaque et deux parties de Sulfate de Cuivre. Conserver ce mélange pendant 24 heures dans un flacon bouché à l'émeri et arroser au taux de 30 grammes (environ le contenu d'une grosse boîte d'allumettes) par 10 litres d'eau. Ce composé ne se conserve pas et doit être employé dans les quelques jours qui suivent la préparation.

Calendrier Horticole pour Mars et Avril.

Fleurs. Dans les localités chaudes l'on commence à semer vers la fin

de Mars ou au début d'Avril les gueules de loup, œillet, reine marguerite, rose trémière, pied d'alouette, pensée, phlox, pétunia, giroflée, salvia, delphinium, coquelicot, salpiglossis, capucine, verveine, bluet, etc... Dans les régions élevées les semis seront fait un peu plus tard.

En mars l'on visite les arbrisseaux pour leur ôter les bois morts et nuisibles ainsi que les branches mal placées. Dans les quartiers chauds les vignes doivent être taillées pendant ce mois.

C'est le mois ou l'on transplante les violettes, opération qui ne doit être répétée que tous les deux ans. C'est également le moment de propager les arums. Cette plante demande beaucoup de fumier et préfère les endroits un peu ombragés, reçevant le soleil du matin par exemple.

Les bulbes de glaïeul, watsonia, chinkerichee, bégonia tubéreux etc... doivent être plantés en cette saison. L'on refait les bordures de toutes sortes.

Légumes. Le potager doit être préparé en Mars afin de recevoir les semis dans le courant du mois et subséquemment. Le fumier de cabri est supérieur au fumier d'étable dans la préparation des planches. Nous recommandons également l'emploi du charbon de terre pour les localités pluvieuses. Dans un petit jardin, les laitues semées en mars peuvent être protégées contre les grosses pluies par des cadres en verre. L'on commence à semer des légumes de toutes sortes : céleri, laitues, salsifis, choux, choux fleurs, petits pois, choux navets, choux de chine, brèdes, radis, carotte, échalotte, épinard, poireaux, haricot etc... Il est mieux de faire les semis en petite quantité et de les répéter tous les 15 jours afin d'avoir des légumes à continuer.

Culture des Fraises. Mars et Avril sont les meilleurs mois pour planter les fraisiers. Les marcottes doivent être plantées en ligne à intervalle de 10 pouces laissant 18 pouces entre les lignes. On doit faire un apport libéral de fumier et de guano phosphaté à la plantation, et arroser les plants avec un peu de salpêtre (environ une cuillère à bouche par arrosoir) un peu plus tard. Les drageons doivent être enlevés systématiquement. Aussitôt que la floraison commence l'on doit enlever les feuilles se trouvant à la base des plants afin de faciliter la pollination des fleurs par les abeilles et permettre aux fruits d'être exposés au soleil. L'on doit prendre soin de placer des tronçons de feuilles d'aloës sous les grappes de fruits, des filets au dessus des plants pour éloigner les "boul-boul", et un appât empoisonné de loin en loin (voir La Revue Agricole — Sept.-Oct./40) pour détruire les limaces et colimaçons.

Cultures Vivrières. Maïs, manioc et patates peuvent être plantés en cette saison. Dans les régions élevées l'on peut commencer à planter les pommes de terre en Mars. Il est indispensable de protéger les plantations contre les ravages du mildiou, par des pulvérisations répétées d'un fongicide cuivrique du genre de la Bouillie Bordelaise. Les lentilles, embéric et voëhms peuvent être plantés en cette saison.

REVUE DES PUBLICATIONS TECHNIQUES

COOMBES, A. N. — Potato Culture in Mauritius. (La culture de la pomme de terre à Maurice).

Dept. Agric. Maur., Bull. **48**, Gen. Ser., pp. 39., Govt. Printer, Mauritius, 1940.

La pomme de terre est une plante herbacée annuelle d'origine Sud-Américaine. Les tubercules qui se développent des tiges souterraines, sont généralement rondes, ovales ou réniformes, selon la variété, la nature du sol et les conditions de nutrition.

Les conditions climatiques ont une influence profonde sur le développement de cette plante qui croît le mieux dans les limites de température de 16 et 24 °C. Les meilleurs rendements s'obtiennent dans les conditions se rapprochant le plus de la limite inférieure. A Maurice, c'est principalement une culture d'hiver. Elle se pratique du niveau de la mer jusqu'à une altitude de 1,400 pieds.

Les sols trop fortement latérisés ne lui conviennent pas. Elle se cultive seule ou en culture intercalaire avec la canne à sucre au début de la plantation de celle-ci. On n'y fait guère de distinction de variétés, les semences, pour la plupart importées, sont désignées par leur lieu d'origine ou leur port d'embarquement. Celles provenant de Mombassa sont plus appréciées que celles venant de Madagascar. A moins d'être obtenues dans des conditions de basses températures, la dégénérescence des semences est très rapide, ce qui ne permet pas en général de les produire localement pour plus d'une seconde plantation. Les planteurs dépendent donc presqu'intégralement des semences étrangères.

Les tubercules devant servir de semences ne devraient guère peser plus de 2 à 3 onces chacune. Pour la plantation, la pratique à Maurice est de les couper en 3 ou 4 morceaux portant chacun au moins un œilleton, les semences produites localement sont trop petites pour être divisées et sont plantées entières. D'après Bonâme, les meilleurs rendements s'obtiennent de plantations faites avec des tubercules entières, pesant en moyenne 3 onces.

Il est de bonne pratique, notamment dans les pays tempérés, de planter des tubercules préalablement germées dont les bourgeons se sont développés à la lumière. A Maurice, cette pratique ne saurait être d'aucun avantage appréciable.

On emploi selon les circonstances et les conditions de plantation 200 à 1,500 kilogrammes de semences par arpent. L'époque de plantation varie

d'après le climat, la localité et le genre de culture de mi-février au début d'octobre. La plantation rapprochée semble donner les meilleurs rendements, cette pratique se justifie du fa t que sous les tropiques, la formation des tubercules a lieu dans un espace resserré autour du plant. Dans de bonnes conditions, on peut obtenir des rendements variant de 8 à 10 tonnes à l'arpent. En culture intercalaire, on obtient de 1 à 3 tonnes.

Il est essentiel de bien ameublir le sol le plus profondément possible en vue d'une bonne récolte, la culture se faisant en terrain plat. On plante généralement à raison de deux boutures ou de deux tubercules par fossé dans lequel on a placé et mélangé avec le sol du fumier de ferme ou de cabri de préférence. La plantation ne se fait jamais à plus de deux pouces de profondeur. Ce sont les femmes et les enfants qui sont chargés de ces travaux ainsi que de la récolte qui se fait 2½ à 3½ mois après.

L'irrigation n'est jamais faite aux plantations de pommes de terre. Dans les régions sèches, on a recours a l'arrosage à la main que l'on pratique régulièrement tous les deux jours à dater de la plantation jusqu'à peu avant la récolte. Il est recommandé de faire un premier buttage environ 30 jours après la plantation et un second 15 ou 30 jours après le premier.

La pomme de terre est une plante qui puise énormément dans les réserves nutritives du sol ; mais il est ancré dans l'esprit des planteurs du pays que l'application d'engrais affecte la bonne conservation de cette denrée. C'est la raison pour laquelle on en fait trés peu usage à l'exception de quelques rares applications de sulfate d'ammoniaque au taux de 50 à 75 Kgs. à l'arpent. Contrairement a la pratique d'appliquer les engrais une trentaine de jours après la plantion, l'auteur recommande de les bien incorporer au sol une semaine ou dix jours avant la plantation. Un engrais complet a moins de tendance à diminuer les qualités de conservation que l'application de sulfate d'ammoniaque seul.

A part les régions du sud où la pulvérisation de bouillie bordelaise est devenue une pratique régulière, les planteurs n'en font pas grand usage. Certains, au lieu de pulvérisateurs, emploient des arrosoirs ; méthode qui n'est pas recommandable à bien des points de vue.

La culture de la pomme de terre en cette île est presqu'exclusivement aux mains des indiens. Elle produit annuellement environ 2,400 tonnes (1936) comparativement à une importation de 1,360 tonnes (moyenne 1935 à 1939). Le produit local est plus apprécié des consommateurs et obtient de ce fait un meilleur marché.

L'auteur est d'opinion que les cultivateurs gagneraient à se grouper en sociétés co-opératives en leur permettant de s'aider mutuellement et de se garantir contre les énormes profits que font à leurs dépens les intermédiaires et les bailleurs de fonds.

Une description détaillée des maladies et des pestes s'attaquant à la pomme de terre est donnée en dernière partie de l'ouvrage avec les moyens propres à leur contrôle.

CRAIG, N. — The Spread of New Varieties of Sugarcane in Mauritius. (L'extension des nouvelles variétés de cannes à sucre à l'île Maurice).

Sugarcane Res. Stat. Maur., Bull. **17**, 11-17 ; Govt. Print. Mauritius 1940.

Pendant près de 30 ans, l'industrie sucrière de ce pays a principalement exploité la Big Tanna blanche. Jusqu'en 1933, cette variété occupait plus de 50% des terres cultivées en cannes. Mais lors du dernier recensement fait en 1938, elle était réduite de 15% tandis que la BH. 10/12 l'égalait, ayant rapidement pris faveur.

On constate que le remplacement de la Big Tanna par la BH. 10/12 s'est fait à un rythme plus accéléré sur les propriétés avec usines compativement à celles sans usines, tandis que les petits cultivateurs se reposent encore aujourd'hui sur les anciennes variétés, notamment la Big Tanna qui occupe environ 90% de leurs plantations.

A sa fondation, en 1930, la Station de Recherches sur la canne à sucre avait pour but principal le remplacement de la Big Tana, mais lorsqu'en 1935, 1936 et 1937 elle distribua ses premières variétés celles ci eurent à affronter surtout la BH. 10/12 que l'on avait rapidement propagée dans l'intervalle. Sur 5 variétés distribuées par la Station, les trois suivantes ont obtenu la faveur des planteurs : la M. 171/30, la M. 72/31 et la M. 134/32. D'après les renseignements obtenus sur les propriétés, l'étendue plantée en les deux premières variétés a à peu près quadruplée de 1939 à 1940 et celle occupée par la dernière s'augmentait d'environ 17 fois pendant la même période.

La M. 171/30 est une variété plus appropriée aux régions de pluviosité moyenne ou élevée situées à de hautes altitudes. Dans ces régions, sa richesse est intermédiaire entre celle de la Big Tanna et de la BH. 10/12, donnant des rendements incontestablement supérieurs à ceux de ces dernières variétés. Elle occupe présentement environ 3.3% de la superficie totale cultivée en cannes.

La M. 72/31 n'occupe seulement que 1.3%, ce qui implique qu'elle est moins appréciée. Elle semble mieux désignée aux régions pluvieuses ou irrigables où elle est suceptible de donner de beaux rendements avec une richesse satisfaisante qui atteint jusqu'à 15% et au dessus.

De toutes les cannes produites par la Station de Recherches, la M. 134/32 est celle qui a obtenu le plus de suffrages. Dans certains endroits elle se montre de beaucoup supérieure à la BH. 10/12. Sa croissance est

très bonne dans toutes les parties de l'île, qu'elles soient sèches ou humides, de terres franches ou rocheuses. Elle a un pouvoir de résistance remarquable à la sécheresse.

L'auteur pense que ces variétés occuperont dans un proche avenir une très forte proportion de la superficie totale cultivée. Il déplore que certaines variétés telles que la M. 168/32 et autres, furent propagées malgré que ces cannes n'aient pas été pour de bonnes raisons recommandées par la Station.

DALLING, Prof. T. — Diseases of Animals : Prevention and Treatment — Contagious Abortion in Cattle. (Avortement contagieux du bétail).

Jour. Royal Agric. Soc. Eng., **101**, 34 – 48, 1940.

Passant en revue différentes maladies affectant les animaux de ferme, l'auteur décrit les causes provoquant l'avortement infectueux chez le bétail.

La principale source d'infection vient naturellement des animaux atteints de la maladie qui sont en contact avec les animaux sains. Pourtant, d'autres sources furent récemment découvertes. En 1936, Karkadinovsky constatait que des rats se trouvant sur les fermes où régnait la maladie étaient aussi infectés par l'agent pathogène *Brucellus abortus*. Ces observations furent ensuite confirmées en Angleterre et en Amérique. Bosworth, en 1937, démontrait que le rat s'infectait par l'ingestion de nourriture contaminée et qu'ensuite la maladie pouvait se transmettre par contact direct d'un animal à l'autre et que l'urine des rats contaminés contenant le microbe pouvait devenir une source d'infection en souillant la nourriture des animaux. Les chevaux peuvent aussi être une source d'infection.

Le meilleur moyen de contrôle de cette maladie consiste en la recherche des animaux déjà atteints par l'application du test de " séro-agglutination " en vue de leur isolement du troupeau et en la désinfection des locaux ; de même que le test doit être appliqué à chaque animal que l'on doit introduire dans le troupeau. La ségrégation des animaux atteints présente d'assez grandes difficultés qui font recourir plutôt à la vaccination. Celle-ci se fait généralement de deux façons : vaccination de la vache environ deux mois avant la saillie avec une culture vivante de *B. abortus* et vaccination des vaches pregnantes ou non avec de la culture tuée. En Amérique, on vaccine avec succès les animaux en bas âge avec de la culture atténuée. Essayée ailleurs, cette méthode a aussi produit de très bons résultats.

Le traitement au sulphanilamide ne semble pas être encore satisfaisant et réclame de plus amples investigations.

L'auteur énumère ensuite de nombreuses autres causes qui, en dehors de *B. abortus*, provoquent l'avortement chez le bétail.

OGILVIE, L., HICKMAN, C. J., & CROXALL, H. E. — The Control of Damping-off by Means of Chemicals applied to the Soil, with special reference to weak Formaldehyde solutions. (Le traitement de la fonte des semis au moyen de fongicides chimiques).

Expt. Stn. Rec., **82**, 784-785 ; 1940.

A la suite de plusieurs essais où un grand nombre de substances chimiques furent employées, l'aldéhyde formique se montra le plus efficace des fongicides appliqués au sol contre les champignons occasionnant la fonte des semis. Employé à des concentrations variant de 1 pour 200 à 1 pour 600 dans l'arrosage des semis, il contrôle très efficacement le développement de ces champignons. Ce traitement est employé avec succès dans les semis de pois, tomates, concombres, etc., mais il semble retarder la germination chez le giroflée ainsi que d'autres plantes ornementales.

STEVENSON, G. C. — An Investigation into the Origin of the Sugar Cane Variety Uba Marot (Etude de l'origine de la canne Uba Marot)

Sugarcane Res. Stat. Maur., Bull. **17**, 3-10, 1940.

En présence des remarquables qualités que possède la Uba Marot comme géniteur, et en raison de l'importance de connaître l'ascendance des variétés employées comme parents dans les travaux d'amélioration, cette étude fut entreprise afin d'élucider l'origine de cette variété.

L'auteur est d'opinion que la Uba Marot est issue d'un croisement naturel entre une forme de *Saccharum spontaneum* et une canne noble. Cette canne sauvage naturalisée à Maurice fut trouvée pour la première fois à Flacq par Mr. P. O. Wiehe en 1937 et a dû exister à Maurice depuis de nombreuses années.

L'évidence des caractères botaniques ainsi qu'une étude cytologique indiquent premièrement que cette canne sauvage appartient au type Indien (Coimbatore) et deuxièmement que la Uba Marot possède les caractères que l'on pourrait s'attendre à voir dans la progéniture d'un croisement *S. spontaneum* (type Coimbatore) × *S. officinarum*.

L'auteur conclut en faisant ressortir le parallèle qui existe entre l'origine de la Uba Marot et celle de la Kassœr, et indique le rôle important que peut jouer la Uba Marot dans la production de variétés résistantes aux attaques du *Phytalus Smithi*.

STATISTIQUES

10. PLUVIOMÉTRIE & TEMPÉRATURE

Pluviométrie (Pouces)

Localités / Mois	Nord							Centre					
	Grand' Baie	Pamplemousses	Pamplemousses (Normale)	Abercrombie	Abercrombie (Normale)	Ruisseau Rose	Belle Vue Maurel	Beau Bois (Moka)	Helvétia	Réduit	Réduit (Normale)	Curepipe*	Curepipe (Normale)†
Nov. 1940...	0.50	1.42	2.13	1.67	2.78	1.43	0.93	3.60	0.96	1.44	2.33	3.27	5.71
Déc. ...	1.89	2.41	4.91	4.27	4.66	4.31	3.62	10.95	17.93	10.05	6.37	11.39	9.71

Localités / Mois	Est				Ouest				Sud				
	Centre de Flacq	Camp de Masque	Palmar	G.R.S.E.	Port-Louis	Case Noyale	Beau-Bassin	La Ferme	Union Park	Mare d'Albert	Riche-en-Eau	Camp Diable	Chemin Grenier
Nov. 1940...	1.68	2.50	1.02	1.07	1.30	0.00	1.68	0.57	2.67	1.93	1.71	1.33	1.32
Déc. ...	8.00	13.71	4.67	8.94	7.84	2.15	7.92	2.25	8.55	14.82	5.06	9.88	10.81

Température °C

Localités	Abercrombie		Beau-Bassin		Réduit				Union Park	
Mois	Max.	Min.	Max.	Min.	Max.	Min.	Moy.	Nor.	Max.	Min.
Nov. 1940...	30.3	21.6	28.0	19.6	26.8	19.2	22.4	21.8	24.4	17.9
Dec. ...	31.8	21.9	29.0	20.5	27.7	20.8	23.9	23.3	27.2	19.4

* Collège Royal. † Jardin Botanique.

20. MARCHÉ DES GRAINS ET ENGRAIS. Nov.-Déc./40

Grains

Riz (Long Boiled & Milchar)	...	75	kilos ...	Rs. 13.12
Dholl		75	„ ...	„ 17.00
Lentille		75	„ ...	„ 15.50
Farine		50	„ ...	„ 9.30

Engrais

Sulfate d'Ammoniaque			... Rs.	195 / tonne
Nitrate de Soude			... „	200 / „
Salpêtre de l'Inde			... „	360 / „
Nitrate de Potasse du Chili			... „	240 / „
Muriate de Potasse			... „	225 / „
Phosphate précipité			... „	250 / „
Guano phosphaté			... „	65 / „

30 COST OF LIVING

Index Numbers for the quarter ending December, 1940.

(Prices given are the means of highest and lowest).

Articles	Prices in 1914	Prices in July to Sept. 1940	Prices in Oct. to Dec. 1940	Index Nos. Oct. to Dec. 1940	Average Index Nos.	Adopted weight	Weighted Index Nos.
	Rs.	Rs.	Rs.				
Rice, good quality, per 75 Ks.	16.00	15.08	15.57	97	88	.15	13.2
„ ration, „ „ „	12.25	8.67	9.75	80			
Dholl, Urhur, „ „ „	16.60	16.50	16.50	99	101	.01	1.0
„ ration, „ „ „	12.70	13.00	13.00	102			
Lentil, red, „ „ „	16.90	18.00	17.50	104	121	.01	1.2
„ black, „ „ „	12.70	18.00	17.50	138			
B ans, „ „ „	16.00	22.50	22.50	141	141	.01	1.4
Flour, Australian, „ „ „	9.75	11.50	12.00	123	116	.03	3.5
„ Indian, „ „ „	9.20	9.50	10.00	109			
Milk, per litre, ...	0.12	0.14	0.14	117	117	.07	8.2
Oil, olive, per 12 litres, ...	30.00	25.50	28.50	95	82	.01	0.8
„ pistachio, per 50 kilos ,...	36.30	25.83	25.50	70			
Tea, per ½ kilo, ...	1.43	1.80	1.80	126	126	.02	2.5
Coffee, per 50 kilos, ...	46.20	34.00	34.00	74	74	.01	0.7
Salt beef, per 150 kilos, ...	132.00	110.00	110.00	83	83	.01	0.8
Salt pork, per 100 kilos ...	93.50	105.00	111.67	119	119	.01	1.2
Butter, per ½ kilo, ...	1.25	1.12	1.25	100	100	.03	3.0
Lard, Chinese, per 50 kilos,...	62.00	43.00	45.00	73	66	.03	2.0
„ European „ „ „ ...	75.00	43.50	43.50	59			
Fresh meat, per ½ kilo, ...	0.36	0.50	0.55	153	153	.17	26.0
CLOTHING							
Shirts, per dozen, ...	18.56	20.00	20.00	108	148	.43	63.6
Boots, per pair, ...	9.00	8.75	9.92	110			
Hats, straw, per dozen, ...	33.58	15.00	15.00	44			
Serge, per metre, ...	8.00	5.50	5.00	63			
Calico „ „	0.22	0.48	0.48	218			
Prints, „ „	0.32	0.55	0.54	169			
Moleskine, „	0.33	1.04	1.04	315			
Regatta „ „	0.31	0.48	0.48	155			
						1.00	129.1

4th January, 1941.

(Sgd.) M. KŒNIG,
Statistician.
Department of Agriculture.

HOW TO PRODUCE STEAM ECONOMICALLY

L. J. COUTANCEAU

DIAGRAMS

For text see p. 7-16

(*For text see pages 7-16*)
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For Boiler pressure 100 lbs /□″ where Q = 660 Calories, Θ_2 = boiler feed water temperature in °C. K_B = coefficient of heat transmission of boiler = 25 Calories per sq. metre heating surface / hour /°C mean temperature difference = 2.323 Calories per sq. foot heating surface /hour/°C mean temperature difference.

Δ_B = mean temperature difference of boiler in °C.

S_B = heating surface of boiler per kilo of water evaporated /hour in sq. ft.

Then $S_B = \frac{(Q - \Theta_2)}{K_B \quad \Delta_B}$ sq. ft. /kilo of water evaporated per hour.

Overload	0	5 o/o	10 o/o	15 o/o	20 o/o	25 o/o	30 o/o	35 o/o	40 o/o
Θ_2	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.	S_B. sq.ft.
65	.6739	.6419	.6127	.5860	.5616	.5391	.5184	.4992	.4834
70	.6682	.6365	.6075	.5811	.5569	.5346	.5140	.4950	.4792
75	.6626	.6811	.6024	.5761	.5522	.5301	.5097	.4908	.4750
80	.6569	.6257	.5972	.5712	.5474	.5256	.5053	.4866	.4709
85	.6513	.6203	.5921	.5663	.5427	.5210	.5010	.4824	.4667
90	.6456	.6149	.5869	.5614	.5380	.5165	.4966	.4782	.4625
95	.6399	.6095	.5818	.5564	.5333	.5120	.4922	.4740	.4583
100	.6343	.6041	.5766	.5515	.5286	.5074	.4879	.4698	.4542
105	.6286	.5987	.5715	.5466	.5238	.5029	.4835	.4656	.4500
110	.6230	.5933	.5663	.5417	.5191	.4984	.4792	.4614	.4458
115	.6173	.5879	.5612	.5367	.5144	.4938	.4748	.4572	.4417
120	.6116	.5825	.5560	.5318	.5097	.4893	.4704	.4530	.4375
125	.606	.5771	.5509	.5269	.5050	.4848	.4661	.4488	.4333
130	.6008	.5717	.5457	.5220	.5003	.4803	.4617	.4446	.4292
135		.5663	.5406	.5171	.4955	.4757	.4574	44.04	.4250
140			.5354	.5121	.4908	.4712	.4530	.4362	.4209
145				.5072	.4862	.4667	.4487	.4321	.4167
150					.4814	.4621	.4444	.4279	.4126
155						.4575	.4400	.4237	.4086
160							.4356	.4195	.4045
165								.4153	.4005
170								.4111	.3964

(*For text see pages 7-16*)
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For Boiler pressure 100 lbs/□" where Q = 660 Calories
Θ_2 = Feed water Temperature in °C

Water evaporated per sq. ft. H.S. / hour $E_s = \frac{\Delta_B \cdot K_B}{(Q - \Theta_2)}$ **Kilos**

Where K_B = 25 Calories/ m^2 H_s / hour / 1°C mean temperature difference
= 2.323 Calories/ sq ft H_s / hour / 1°C mean temperature difference

Evaporation from and at 100 °C= $\frac{E_s (Q - \Theta_2}{L\ 100 = 536}$ **Kilos/ sq. ft. H.S/ hour**

Overload	0	5 o/o	10 o/o	15 o/o	20 o/o	25 o/o	30 o/o	35 o/o	40 o/o
Θ_2	E_s	E_s	E_s	E_s	E_s	E_s	E_s	E_s	E_s
65	1.4831	1.558	1.634	1.706	1.780	1.854	1.928	2.002	2.077
70	1.496	1.571	1.648	1.720	1.795	1.870	1.945	2.019	2.094
75	1.509	1.584	1.662	1.735	1.810	1.886	1.961	2.037	2.112
80	1.521	1.598	1.676½	1.750	1.826	1.902	1.978	2.054	2.130
85	1.535	1.612	1.691	1.765	1.842	1.918	1.995	2.072	2.149
90	1.548	1.626	1.706	1.781	1.858	1.935	2.013	2.091	2.168
95	1.562	1.640	1.721	1.796	1.874	1.958	2.031	2.109	2.187
100	1.576	1.655	1.736½	1.812	1.891	1.970	2.049	2.128	2.206
105	1.590	1.670	1.752	1.828	1.908	1.988	2.067	2.147	2.226
110	1.605	1.685	1.768	1.845	1.926	2.006	2.086	2.166	2.247
115	1.619	1.701	1.784	1.862	1.943	2.024	2.105	2.186	2.267
120	1.634	1.716	1.801	1.879	1.961	2.043	2.125	2.206	2.288
125	1.650	1.732	1.818½	1.897	1.980	2.062	2.145	2.227	2.310
130	1.665	1.749	1.835	1.915	1.998	2.081	2.165	2.248	2.331
135		1.765	1.852	1.933	2.017	2.101	2.185	2.270	2.354
140			1.870	1.952	2.037	2.122	2.206	2.291	2.376
145				1.971	2.057	2.142	2.228	2.313	2.399
150					2.077	2.163	2.250	2.336	2.423
155						2.185	2.272	2.359	2.447
160							2.295	2.383	2.471
165								2.407	2.496
170								2.432	2.552

(*For text see pages 7-16*)
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For Boiler pressure 100 lbs/□" where Q = 660 Calories, Θ_2 = boiler feed water temperature in °C — For on excess of air of 65% furnace temperature t_o = 1250 °C. t_1 = flue gas temperature after boiler in °C. Θ_1 = temperature of water entering Economiser in °C.

If t_2 = flue gas temperature after Economiser in °C.

Then $t_2 = \dfrac{\Theta_1 (t_o - t_1) + Qt_1 - \Theta_2 . t_o}{(Q - \Theta_2)}$ in °C.

Overload	0	5o/o	10o/o	15o/o	20o/o	25o/o	30o/o	35o/o	40o/o
Θ_2	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C	t_2 = °C
65	247°	260°	274°	290°	306°	323°	341°	362°	381°
70	238½°	251½°	266°	282°	298°	315°	333½°	354½°	373½°
75	230°	243°	257½°	273½°	290°	307°	325½°	347°	366°
80	221°	234½°	249°	265°	281½°	299°	317½°	339°	358½°
85	212°	225½°	240°	256½°	273°	290½°	309½°	331°	351°
90	203°	216½°	231°	248°	264½°	282°	301°	323°	343°
95	193½°	207½°	222°	239°	256°	273½°	292½°	315°	335°
100	184°	198°	213°	230°	247°	265°	284°	306½°	327°
105	174½°	188½°	203½°	221°	238°	256°	275½°	298°	318½°
110	165°	179°	194°	211½°	229°	247°	266½°	289½°	310°
115	155°	169°	184½°	202°	219½°	238°	257½°	280½°	301½°
120	145°	159°	174½°	192°	210°	228½°	248½°	271½°	292½°
125	134½°	149°	164½°	182°	200°	219°	239°	262½°	283½°
130	124°	138½°	154½°	172°	190°	209°	229½°	253°	274½°
135		128°	144°	162°	180°	199°	220°	243½°	265°
140			133°	151½°	170°	189°	210°	234°	255½°
145				141°	159½°	179°	200°	224°	246°
150					149°	168½°	189½°	214°	236°
155						158°	179°	203½°	226°
160							168½°	193°	216°
165								182½°	205½°
170								172°	195°

(*For text see pages 7-16*)

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For Boiler pressure of 100 lbs/□" boiler working with 65 o/o excess of air.

If Θ_1 = temperature of water entering Economiser in ° C.

Θ_2 = temperature of water leaving Economiser in ° C.

t_1 = flue gas temperature after boiler in ° C.

t_2 = flue gas temperature after Economiser in ° C.

Δ_E = mean temperature difference of Economiser in ° C.

Then $\Delta_E = \dfrac{\{(t_1-\Theta_2)-(t_2-\Theta)_1\}}{\log_e \dfrac{t_1-\Theta_2}{t_2-\Theta_1}}$ ° C.

Overload	0	5 o/o	10 o/o	15 o/o	20 o/o	25 o/o	30 o/o	35 o/o	40 o/o
Θ_2	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C	Δ_E °C
65	182°	195°	209°	225°	241°	258°	276°	297°	316°
70	175°	188½°	202½°	218½°	234½°	251½°	269½°	291°	310°
75	168°	181½°	196°	212°	228°	245°	263°	284½°	303¾°
80	161°	174½°	189°	205°	221¼°	238½°	256½°	278°	297½°
85	154°	167½°	182°	198°	214½°	232°	250°	271½°	291°
90	147°	160½°	175°	191°	207¾°	225°	243¼°	265°	284½°
95	140°	153½°	168°	184°	201°	218°	236½°	258½°	278°
100	132½°	146°	160½°	177°	194°	211°	229¾°	251¾°	271¼°
105	125°	138½°	153°	170°	187°	204°	223°	245°	264½°
110	117½°	131°	145½°	162½°	179½°	197°	216°	238°	257¾°
115	109½°	123½°	138°	155°	172°	190°	209°	231°	251°
120	101½°	115½°	130½°	147½°	164½°	182½°	201¾°	223¾°	244°
125	93½°	107½°	123°	139½°	157°	175°	194½°	216½°	236¾°
130	84½°	99°	115°	131½°	149°	167½°	186¾°	209½°	229½°
135		90½°	106°	123½°	141°	159½°	179½°	201¾°	222¼°
140			97°	115°	133°	151½°	171½°	194½°	214¾°
145				107°	125°	143½°	163½°	186½°	207¼°
150					116½°	135½°	155½°	178½°	199½°
155						127°	147°	170½°	191¾°
160							138½°	162½°	183¾°
165								154°	175½°
170								145¾°	167½°

(*For text see pages 7-16*)

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For Boiler pressure of 100 lbs/□" boiler working with 65 o/o excess of air
If Θ_1 = temperature of water entering Economiser in ° C.
Θ_2 = temperature of water leaving Economiser in ° C.
K_E = coefficient of heat transmission of Economiser, = 21 Calories/sq. metre heating surface/hour/ ° C mean temperature difference = 1.95 Calories/sq. foot H.S. per hour / ° C mean temperature difference.
S_E = Heating surface of Economiser/kilo of water heated/hour in sq. ft.
Δ_E = mean temperature diffence of Economiser in ° C.

Then $S_E = \frac{(\Theta_2 - \Theta_1)}{K_E . \Delta_E}$ square ft.

Overload	0	5o/o	10o/o	15o/o	20o/o	25o/o	30o/o	35o/o	40o/o
Θ_2	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.	S_E sq. ft.
65	0	0	0	0	0	0	0	0	0
70	.01473	.01371	.01274	.01172	.01091	.01019	.00951	.0088	.00826
75	.03067	.02846	.02638	.02420	.02354	.01996	.01946	.0180	.01687
80	.048	.04436	.04099	.03750	.03474	.0322	.02994	.02765	.02586
85	.0669	.06162	.05678	.0517	.04779	.0442	.04096	.03775	.03521
90	.0877	.08076	.07383	.0671	.06169	.0569	.05262	.04835	.04504
95	.1108	.101	.09237	.0834	.07654	.0705	.06497	.05948	.05534
100	.1364	.1237	.11253	.1012	.09257	.0849	.07804	.07127	.06609
105	.1652	.149	.13482	.1205	.1098	.1004	.09189	.08371	.07746
110	.1978	.1774	.1594	.1417	.1284	.1170	.10680	.09688	.08944
115	.2355	.2093	.1867	.1650	.1489	.1349	.12270	.1110	.1021
120	.2776	.2440	.2177	.1911	.1712	.1544	.13973	.1260	.1156
125	.3306	.2860	.25	.2202	.1960	.1756	.15826	.1419	.1299
130	.3939	.3364	.2896	.2528	.2235	.1989	.17830	.1592	.1450
135		.3964	.3384	.2898	.2541	.2250	.20005	.1778	.1614
140			.395	.3331	.2886	.2535	.22410	.1978	.1790
145				.3838	.3284	.2854	.25055	.2198	.1977
150					.3741	.3220	.28030	.2438	.2183
155						.3636	.31355	.2705	.2406
160							.35105	.3001	.2649
165								.3331	.2917
170								.3691	.3217

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For Boiler Pressure 100 lbs/ □' where Q = 660 Calories, Θ_2 = boiler feed water temperature in °C- and H_s=heat absorbed by boiler = h (t_o - t_1) Calories, where h = 1.5 Calories /kilo bagasse/1°C when working boiler at a CO_2 content of 12 % corresponding to 65 % excess of air giving as furnace temperature t_o = 1250 °C. t_1 = flue gas temperature after boiler in °C.

then $E = \frac{H_s}{Q - \Theta_2}$ kilos of water evaporated/hour/kilo of bagasse.

Overload	0	5o/o	10o/o	15o/o	20o/o	25o/o	30o/o	35o/o	40o/o
Θ_2	E	E	E	E	E	E	E	E	E
65	2.5285	2.496	2.4605	2.42	2.38	2.337	2.291	2.2385	2.192
70	2.55	2.517	2.4814	2.441	2.40	2.357	2.311	2.258	2.210
75	2.572	2.5385	2.5025	2.4615	2.425	2.377	2.331	2.277	2.229
80	2.594	2.56	2.5235	2.483	2.441	2.397	2.351	2.297	2.248
85	2.6165	2.5826	2.546	2.504	2.463	2.418	2.371	2.316	2.268
90	2.64	2.605	2.5684	2.526	2.484	2.440	2.392	2.337	2.288
95	2.663	2.628	2.591	2.549	2.506	2.461	2.413	2.358	2.308
100	2.6866	2.652	2.614	2.5714	2.530	2.483	2.435	2.379	2.329
105	2.711	2.676	2.638	2.5946	2.551	2.505	2.457	2.40	2.349
110	2.7855	2.70	2.662	2.6182	2.574	2.528	2.479	2.422	2.370
115	2.76	2.725	2.686	2.6422	2.598	2.551	2.502	2.444	2.391
120	2.786	2.750	2.711	2.6667	2.622	2.575	2.525	2.467	2.414
125	2.812	2.776	2.736	2.6915	2.647	2.599	2.549	2.489	2.437
130	2.8386	2.802	2.762	2.717	2.672	2.624	2.573	2.513	2.460
135		2.8286	2.7885	2.743	2.697	2.649	2.597	2.537	2.484
140			2.8154	2.769	2.723	2.674	2.622	2.561	2.508
145				2.796	2.750	2.70	2.648	2.586	2.532
150					2.776	2.727	2.674	2.612	2.556
155						2.753	2.70	2.638	2.581
160							2.727	2.664	2.607
165								2.691	2.633
170								2.717	2.660

(*For text see pages 7-16*)

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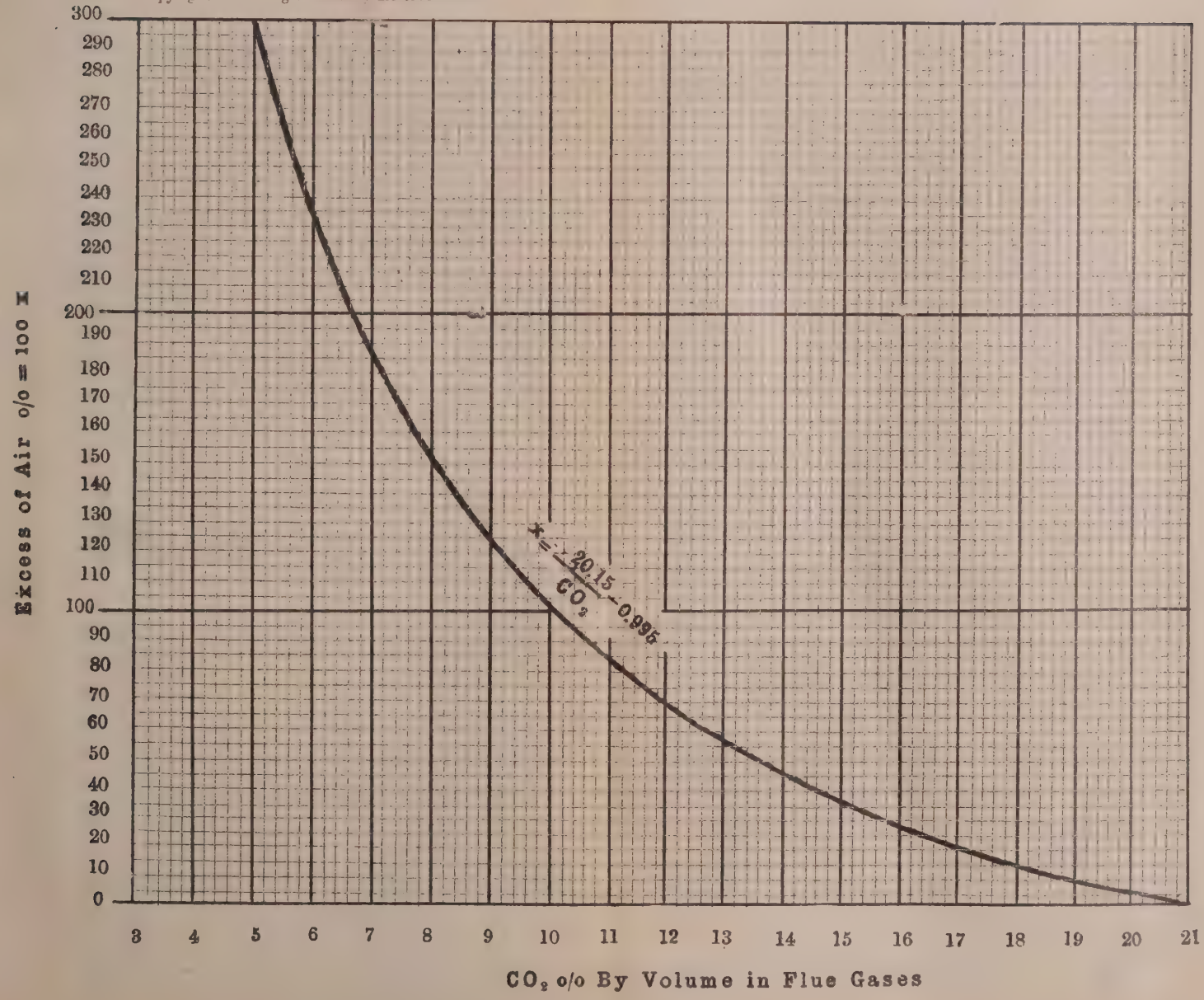

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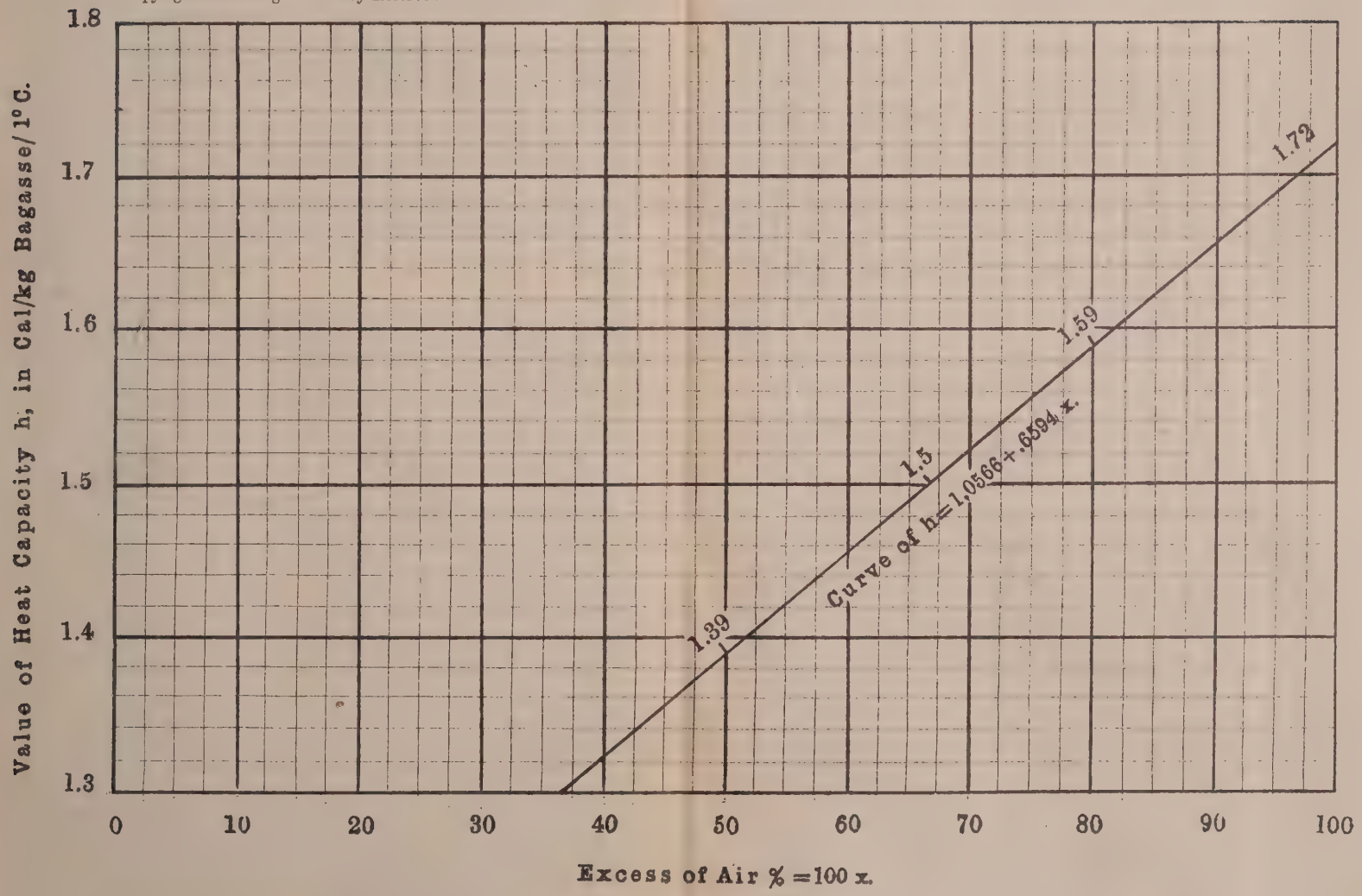

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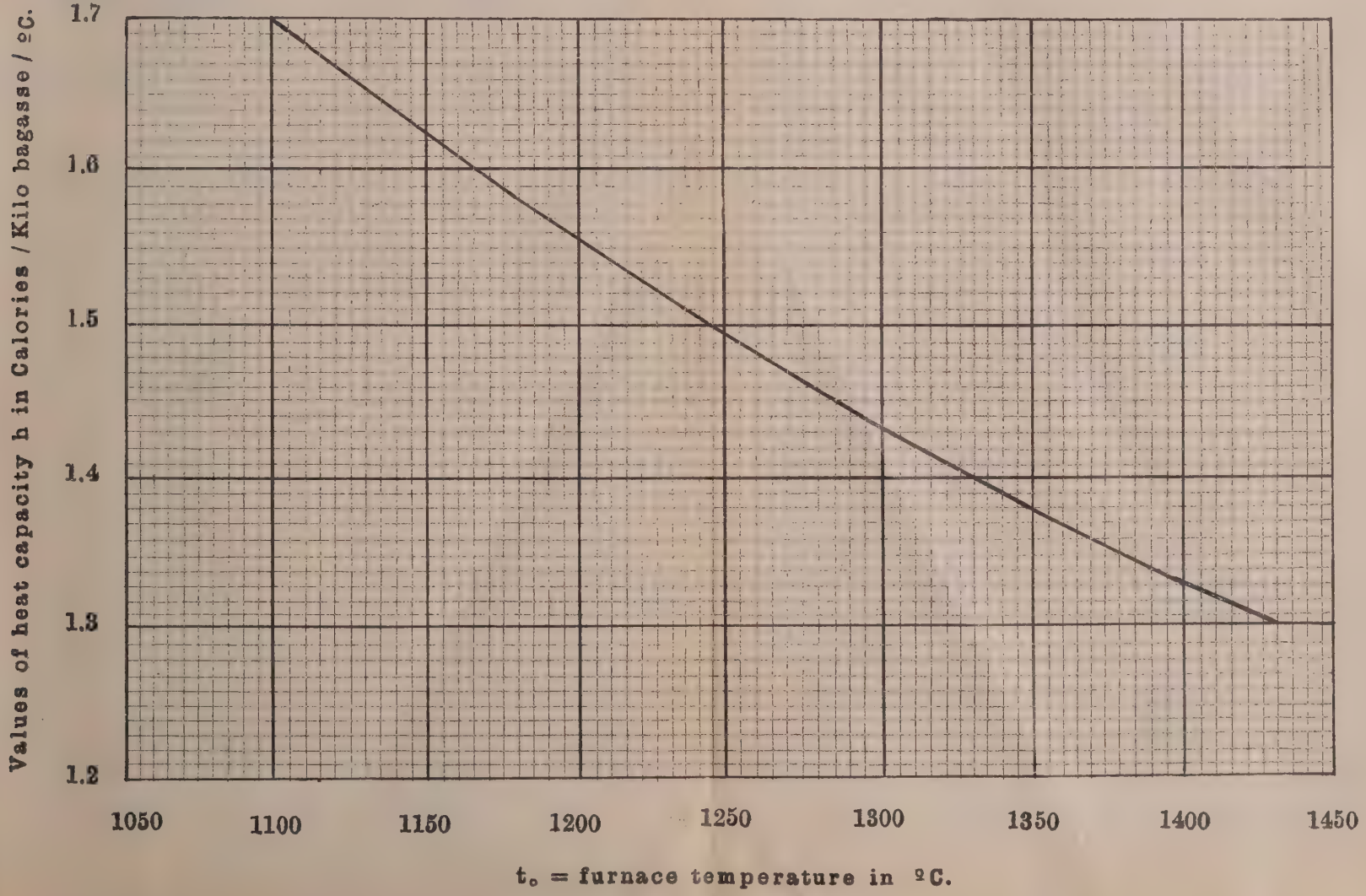
For multitubular fire-tube boilers with CO_2 content = 12 o/o for 12½ o/o fibre cane containing 51 o/o fibre 3 o/o sugar and 45 o/o moisture and calorific value of dry bagasse = 2435 calories / kilo.

Relation between h = heat capacity of gases in Calories / kilo bagasse / 1 °C and to the furnace temperature in °C where to = $\frac{1809.64 + (h - 03513)\ t_a + 0.732\ t_b}{h}$ **°C**

where t_a and t_b – the air and bagasse h temperature are taken as 30 °C.



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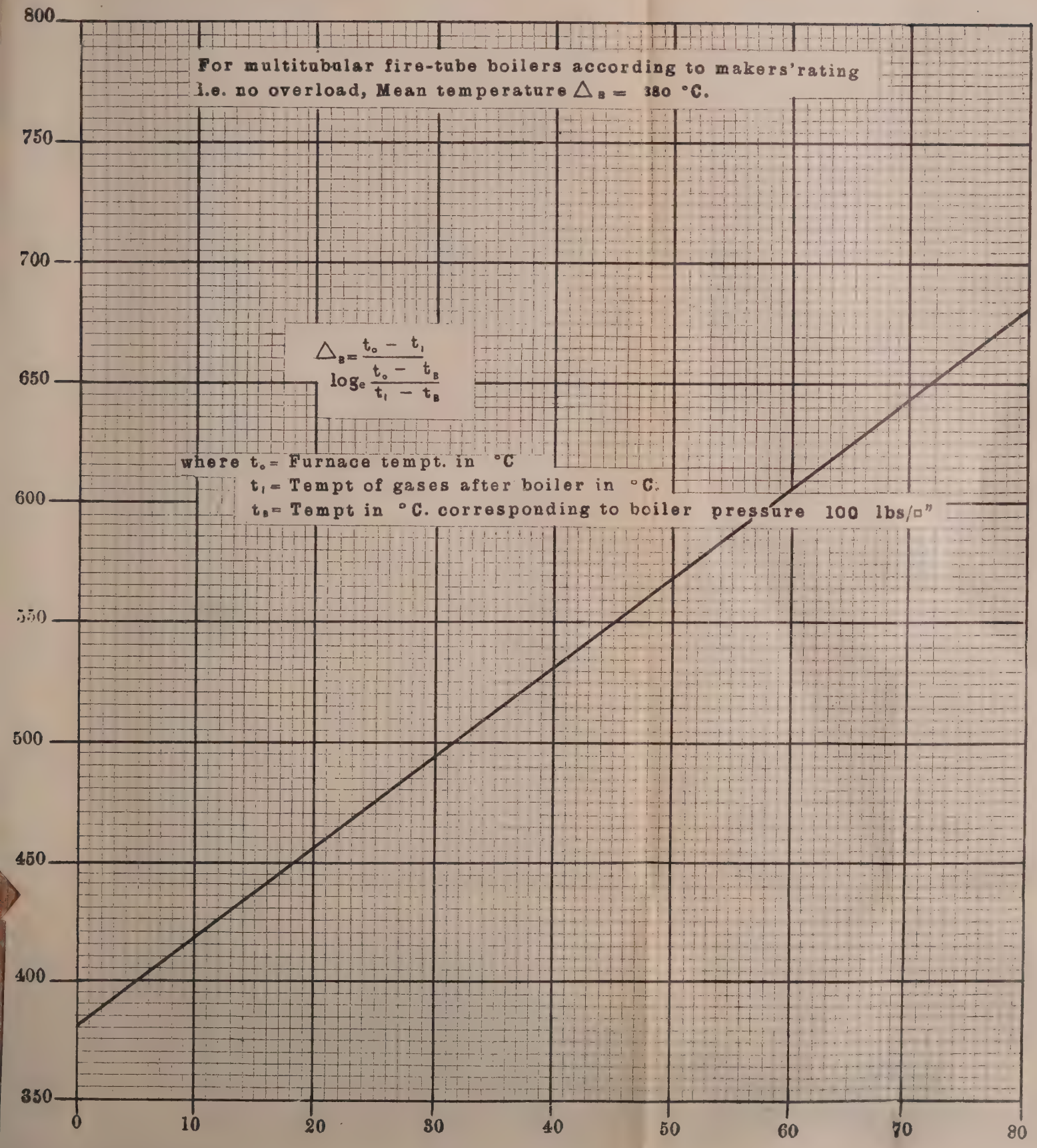

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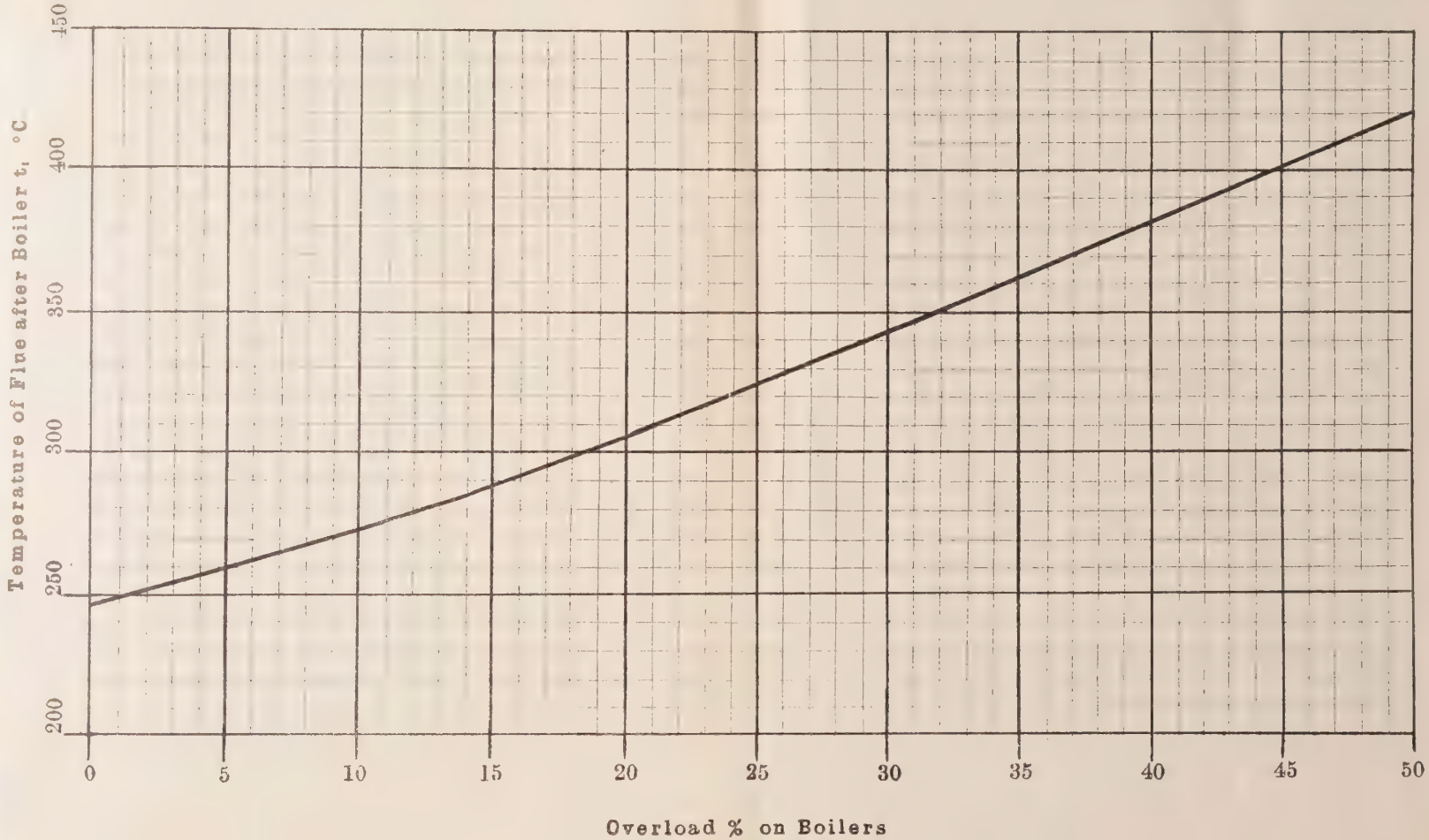
For multitubular fire-tube boilers according to maker's rating i.e. no overload, Mean temperature difference = $\triangle_s$ = 380 °C.

$$\triangle_s = \frac{t_o - t_i}{\log_e \frac{t_o - t_s}{t_i - t_s}}$$

t_o = Furnace temperature in °C = 1250 °C when excess of air is 65% or CO_2 content = 12% giving as heat capacity of gases h = 1.5 Calories/Kilo bagasse/1 °C.— t_s = tempt. of steam at boiler pressure = 170 °C. when pressure = 100 lbs/□". - t_i = temperature of gases after boiler in °C.



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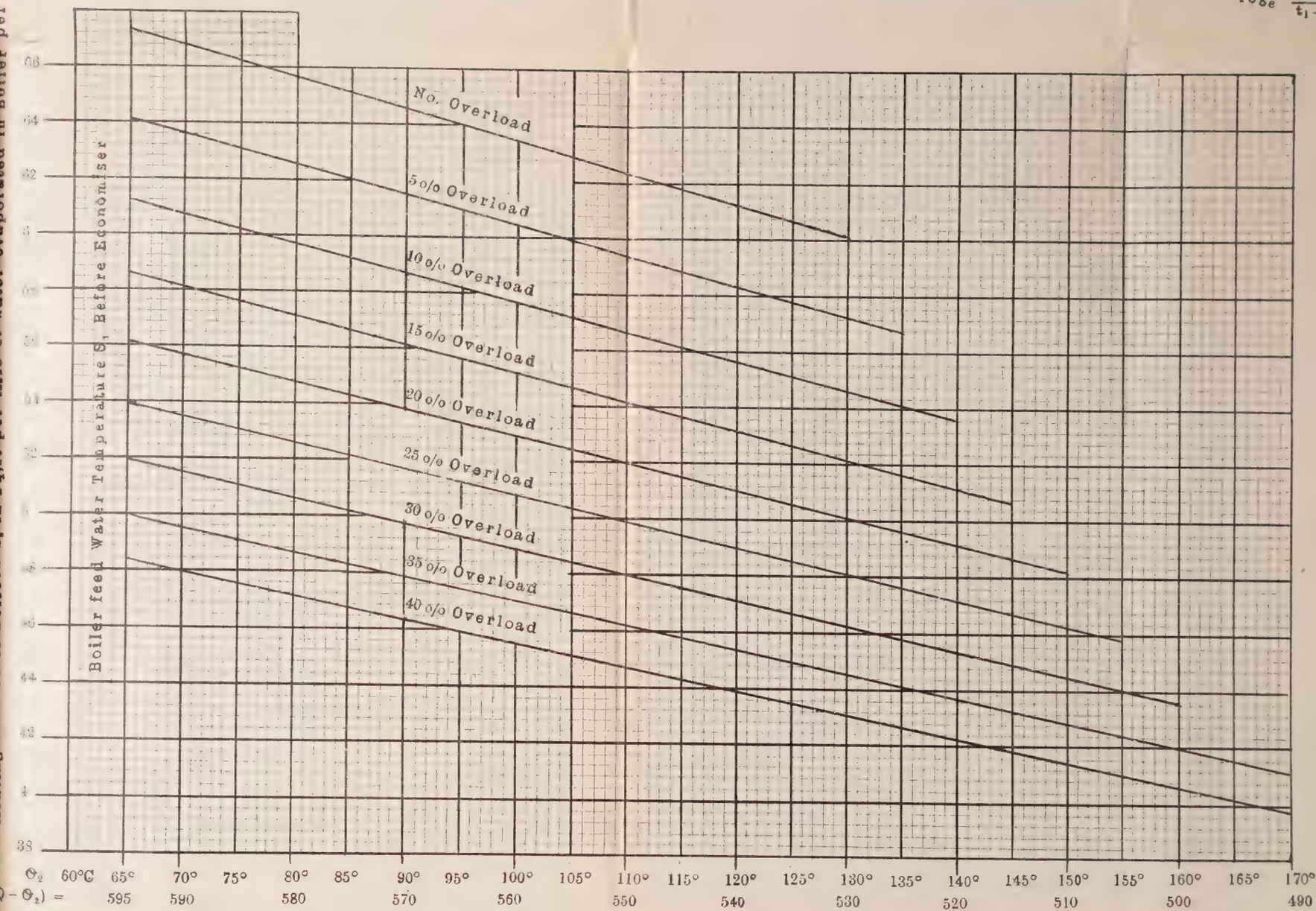
BOILERS

For Boiler pressure 100 lbs /□" where total heat of steam of that pressure or Q = 660 Calories. And temperature of steam of that pressure t_B = 170° C. Heat absorbed by boiler = $H_2 = (t_0 - t_1)$ where to the furnace temperature = 1250°C & t_1 = temperature of flue gases after boiler in °C If Θ_2 = feed water temperature entering Boiler in °C.

Calories required per Kilo of water = $(Q - \Theta_2)$

Heating surface of Boiler per kilo of water feed to Boiler = $S_B = \dfrac{(Q - \Theta^2)}{K_B \, \Delta_B}$ where K_B = Coefficient of heat transmission of Boiler = 25 Calories per sq.meter heating surface per Hour per °C mean tempt difference

& Δ_B = mean temperature difference = $\dfrac{t_0 - t_1}{\log_e \dfrac{t_0 - t_B}{t_1 - t_B}}$



Boiler Feed Water Temperature Θ_2 in C° after Economiser and Calories required per Kilo of water $(Q-\Theta_2)$

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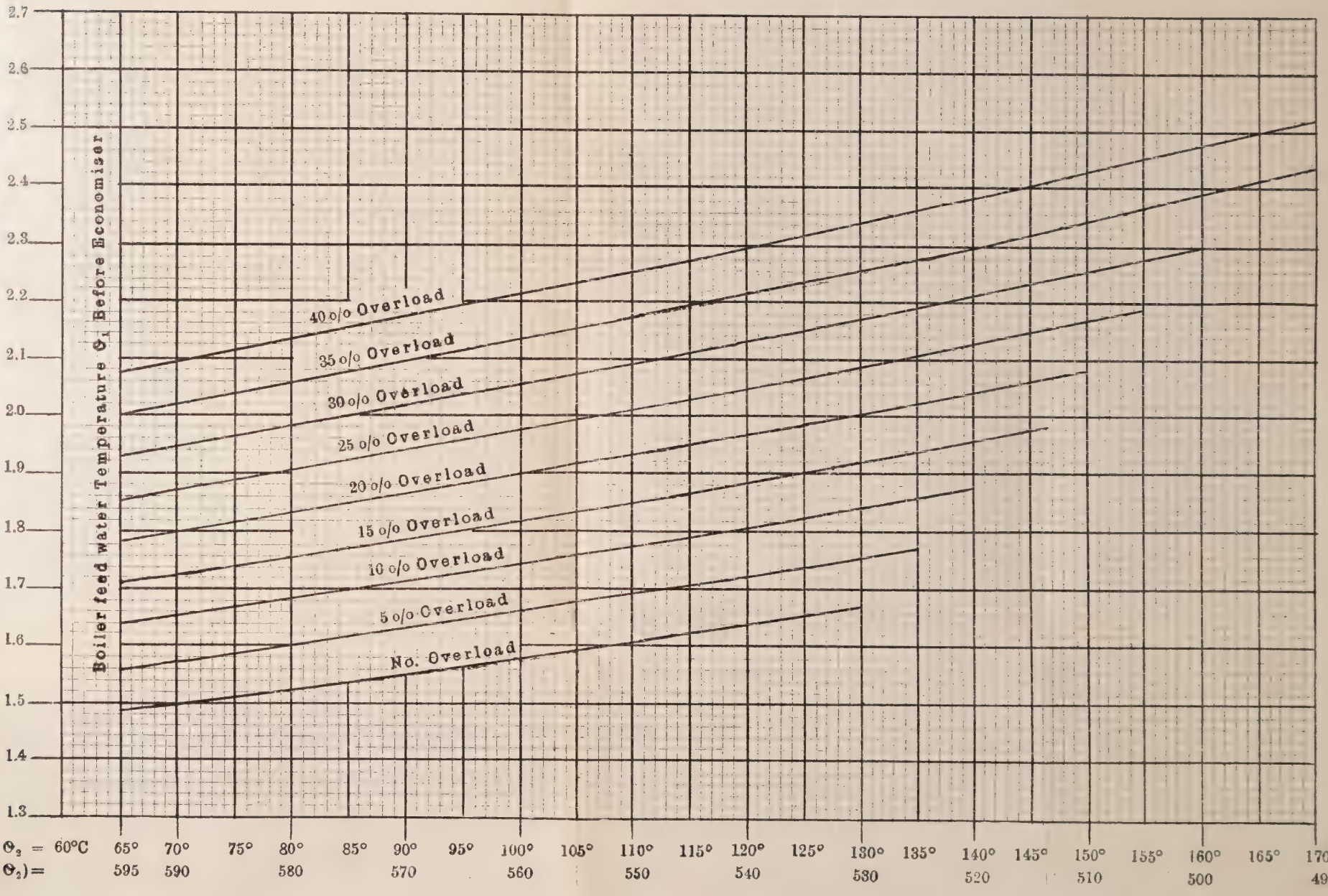
$$\text{Evaporation from and at } 100° = \frac{E_s\ (Q - \Theta_2)}{L\ 100° = 536} \text{ Kilos/sq ft HS/hour}$$

For Boiler pressure 100 lbs/□", Where Q = 660 Calories & Θ_2 = feed water temperature in °C

$$\text{Water evaporated per sq. ft, HS/hour} = E_s = \frac{\Delta_B \quad K_B}{(Q - \Theta_2)} \text{ Kilos}$$

Where K_B = 25 Calories /m² HS/hour/1°C mean temperature difference
= 2.323 Calories /sq ft HS/hour 1°C mean temperature difference



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ECONOMISER

For boiler pressure 100 lbs/ □" where the total heat of steam at that pressure Q = 660 Calories

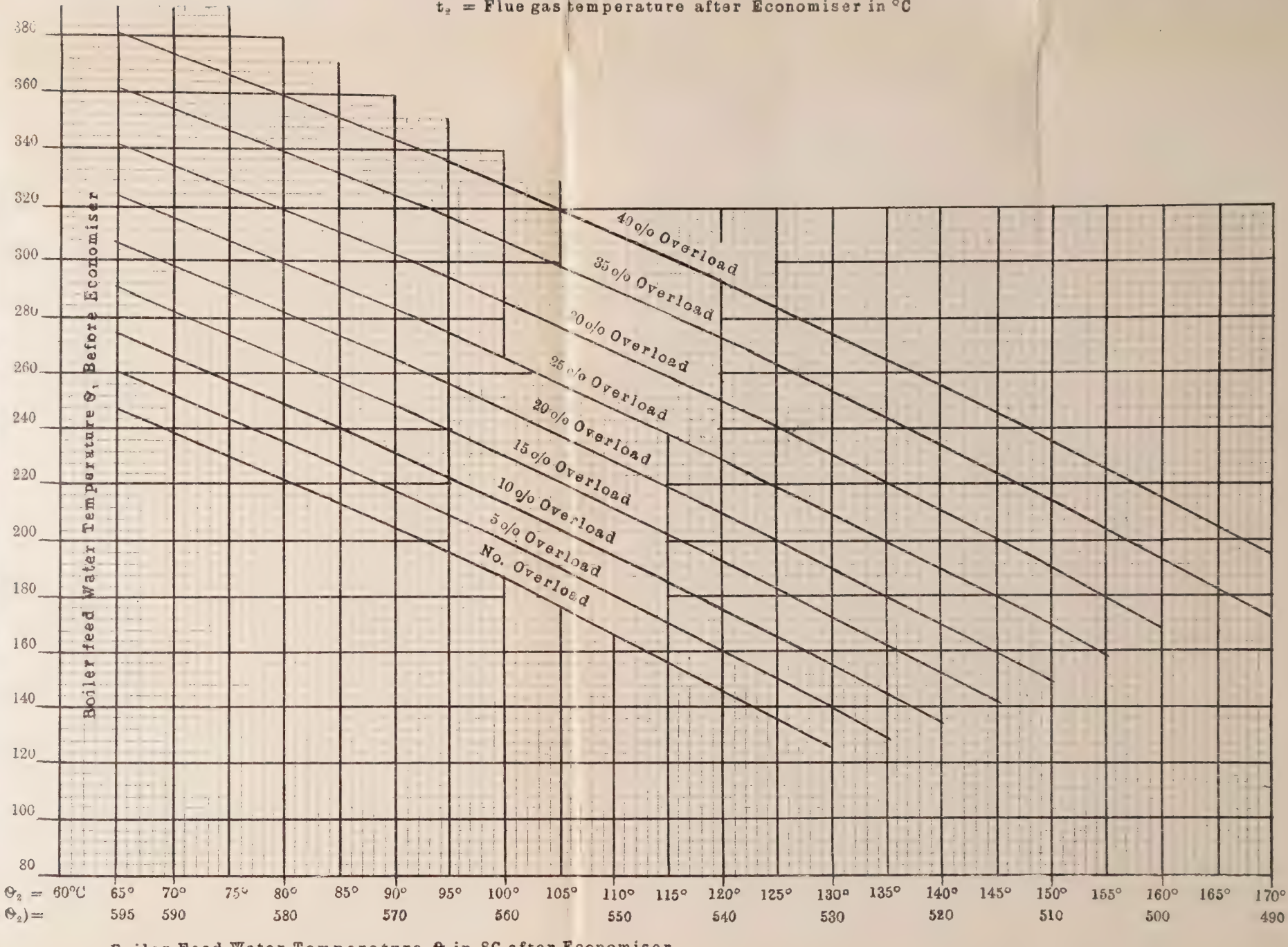
Temperature of water Economiser entering boiler $t_2 = \dfrac{\Theta_1 (t_0 - t_1) + Q t_1 - \Theta_2 t_0}{(Q - \Theta_2)}$

where Θ_1 **= Temperature of water before Economiser = 65°C**

t_0 **= Furnace temperature = 1250°C**

t_1 **= Flue gas temperature after boiler in °C**

t_2 **= Flue gas temperature after Economiser in °C**



Boiler Feed Water Temperature Θ_1 in °C after Economiser and Calories required per kilo of Water ($Q - \Theta_2$)

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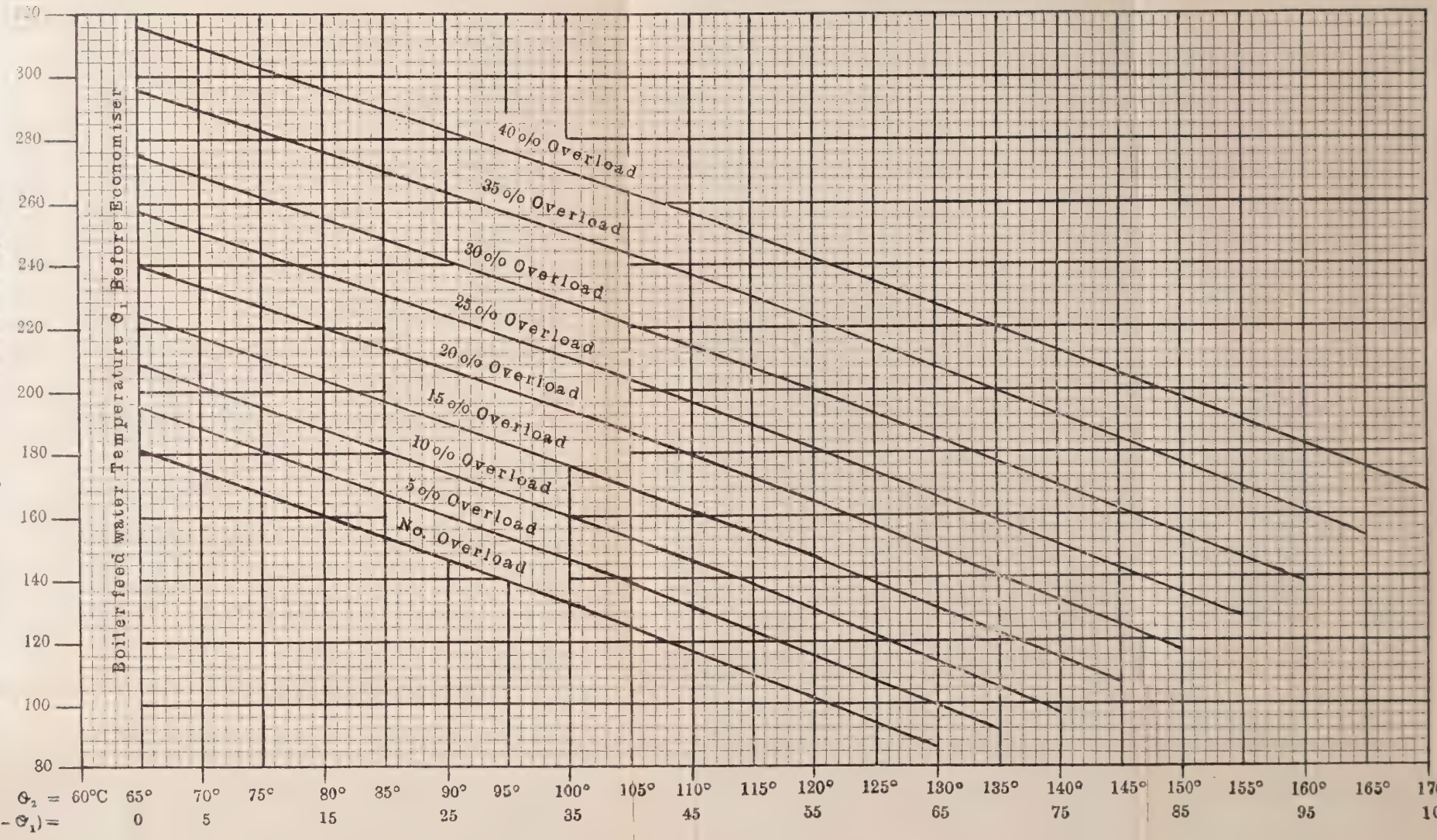
ECONOMISER

$$\text{Mean Temperature Difference} = \Delta_t = \frac{\{(t_1 - \theta_2) - t_2 - \theta_1\}}{\log_e \frac{t_1 - \theta_2}{t_2 - \theta_1}} \text{ in °C}$$

where t_1 = Flue gas temperature after boiler and before economiser
t_2 = Flue gas temperature after economiser in °C
θ_1 = Feed water temperature entering economiser = 65°C
θ_2 = Feed water temperature leaving economiser & entering Boiler in °C



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ECONOMISER

Heating Surface of Economiser found from the formula:-

$$(\Theta_2 - \Theta_1) = \frac{K.\ S_E\{(t_1 - \Theta_2) - (t_2 - \Theta_1)\}}{\log_e \frac{t_1 - \Theta_2}{t_2 - \Theta_1}}$$

Where Θ_1 = Feed water Temperature in °C entering economiser and taken at 65 °C

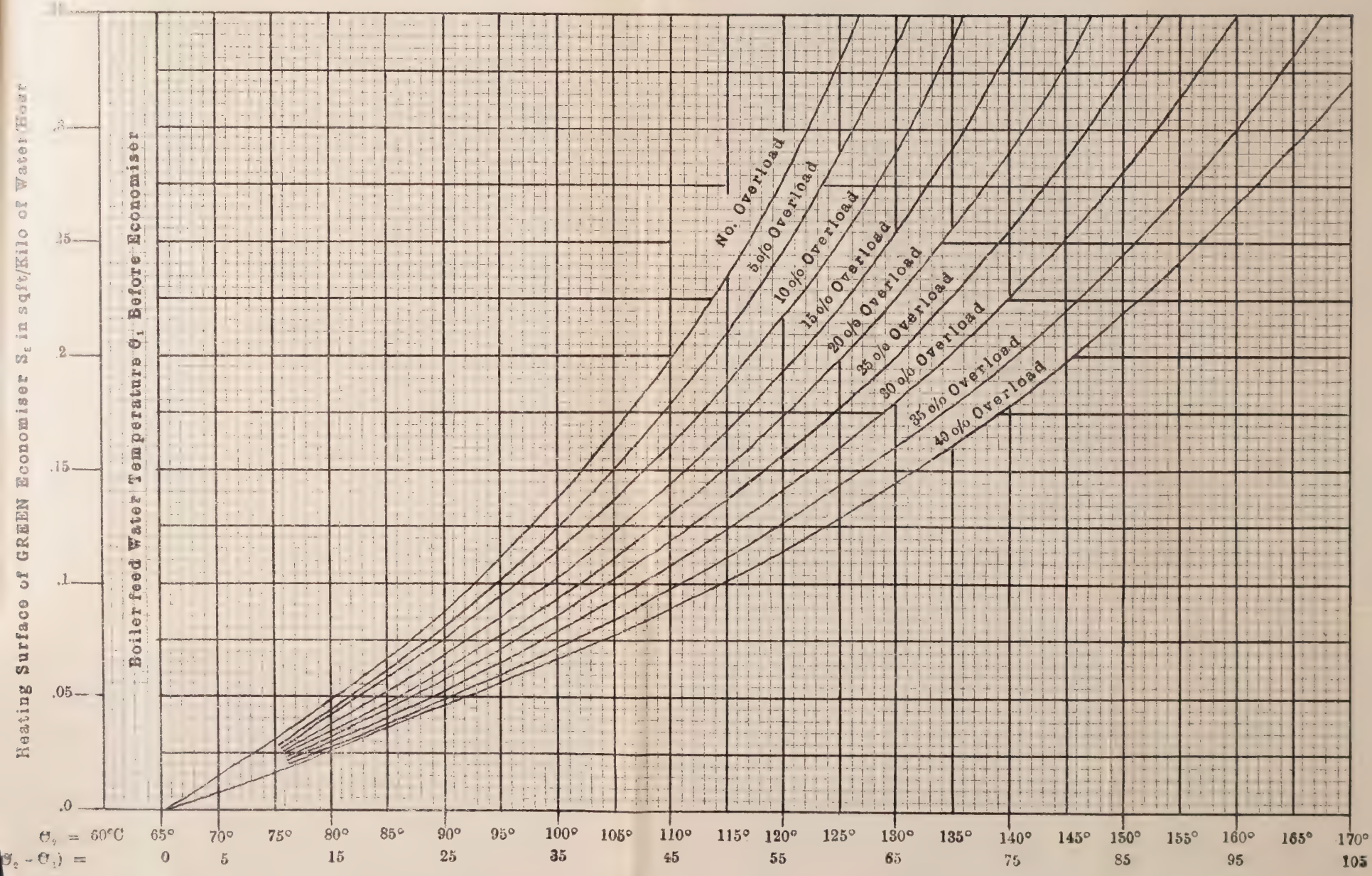
K = Cœfficient of heat Transmission of GREEN Economiser = 21 Calories/m² of heating surface /hour/°C of mean Temperature difference.

t_1 = Flue gas temperature after Boiler in °C.

t_2 = Flue gas temperature after Economiser in °C

Curves calculated for CO_2 content of 12 o/o giving an excess of air of 65 o/o when furnace temperature t_0 = 1250 °C Mean temperature difference of fire tube boiler at maker's rating i.e. no overload Δ_B=380 °C. Boiler pressure = 100 lbs/□" or t_B = 170 °C heat capacity of gases h = 1.5 Cal/ Kilo bagasse /1°C

Heating Surface as advised by Messrs E. GREEN & sons Ltd. 35 sq.ft./ Kilog of Water supplied /hour



BOILERS AND ECONOMISER

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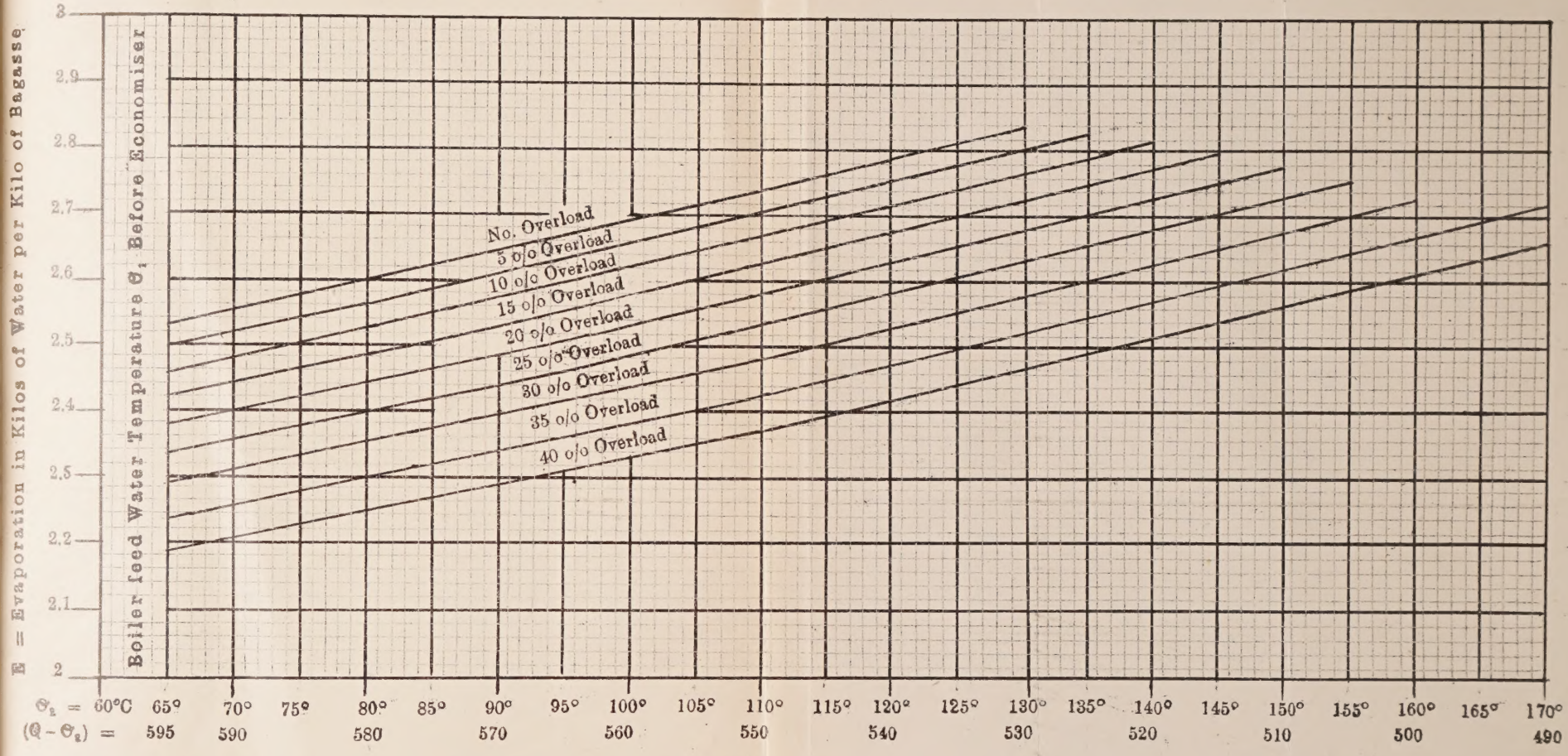
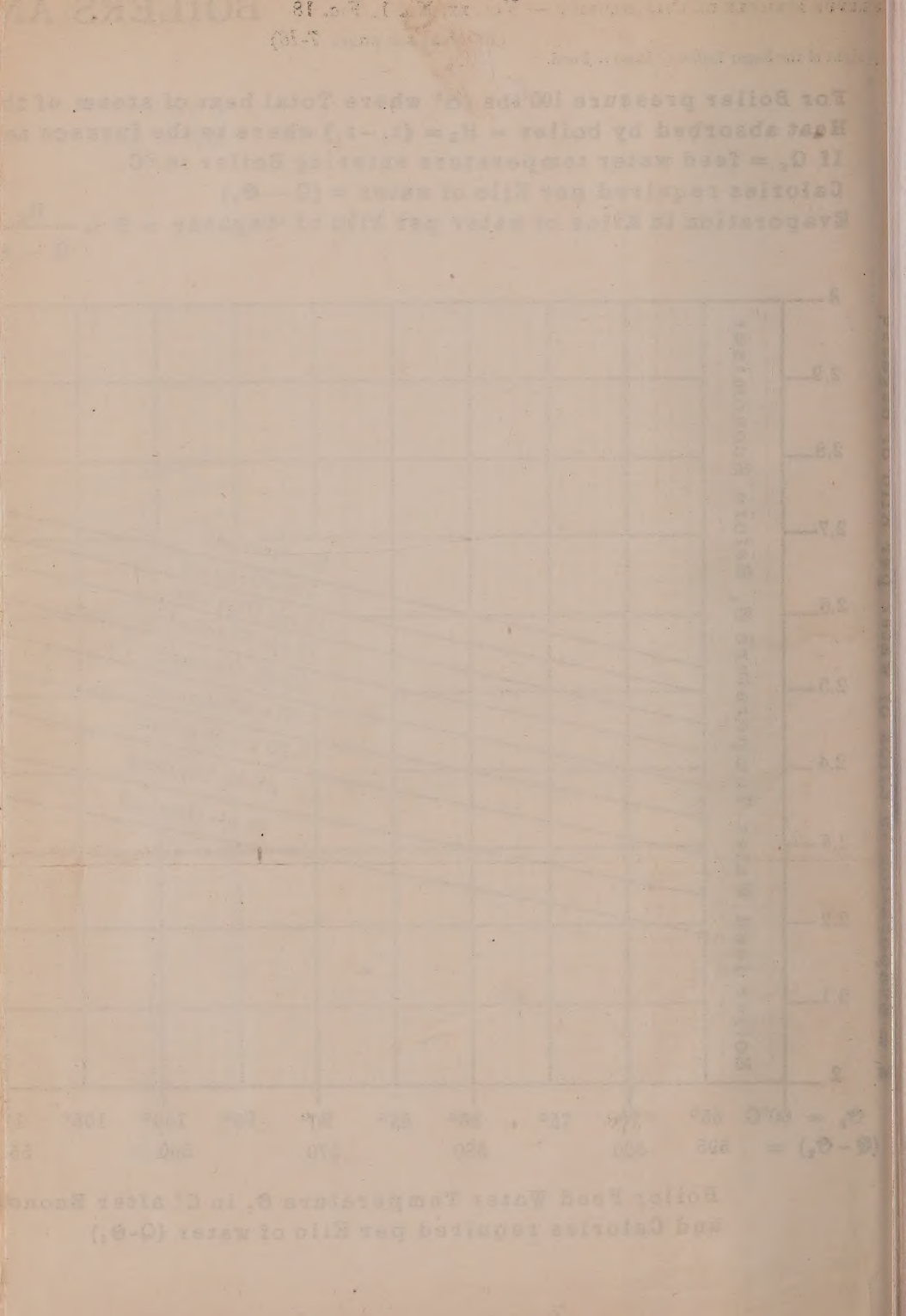
For Boiler pressure 100 lbs /□" where Total heat of steam of that pressure or Q = 660 Calories.
Heat absorbed by boiler = $H_s = (t_0 - t_1)$ where to the furnace temperature = 1250°C & t_1 = temperature of flue gases after Boiler in °C.
If Θ_2 = feed water temperature entering Boiler in °C.
Calories required per Kilo of water = $(Q - \Theta_2)$
Evaporation in Kilos of water per kilo of bagasse = $E = \frac{H_s}{Q - \Theta_2}$



Boiler Feed Water Temperature Θ_2 in C° after Economiser
and Calories required per Kilo of water $(Q-\Theta_2)$



Entretien des Tracteurs Agricoles.

ORGANES de TRANSMISSION.

Ce serait une erreur de croire qu'un tracteur ayant des organes extrêmement robustes peut se passer d'entretien. Il est donc soumis à des efforts continuels et prolongés qui, si son entretien est négligé et s'il ne reçoit pas un graissage correct, peuvent sans le rendre forcément inutilisable, en faire une source de dépenses et d'ennuis.

BOITES DE VITESSES ET DIFFÉRENTIEL.— Au même titre que pour le moteur, le mauvais graissage de la boîte de vitesses ou du différentiel dans un tracteur peut être la cause d'une dépréciation rapide, d'arrêts prolongés et de dépenses tout à fait hors de proportion avec le coût du lubrifiant.

Il serait tout à fait étonnant qu'une huile quelconque choisie au hasard donne de bons résultats. L'huile doit posséder une adhérence et un corps tels qu'elle ne puisse être chassée des surfaces en contact, malgré les pressions rencontrées. Elle doit être assez fluide pour qu'il se produire un arrosage constant des engrenages et que ceux-ci ne puissent tracer leur chemin dans le lubrifiant.

Dans la plupart des cas, la boîte de vitesses et le différentiel sont, dans les tracteurs agricoles, réunis en un seul carter. Il suffit que la partie inférieure des engrenages baigne dans l'huile pour que cette huile soit distribuée à tout le mécanisme.

COMMANDE DES ROUES MOTRICES.— La commande des roues motrices, dans les tracteurs agricoles, peut être, soit une :

Commande directe.— Dans ce cas, la commande est basée sur le même principe que celle des voitures automobiles. Elle ne comporte aucun graissage spécial, sauf en ce qui concerne les roulements des roues qui sont graissés généralement par l'intermédiaire de graisseurs à graisse ou de graisseurs à pression.

Commande par chaînes.— Dans ce cas, l'essieu arrière est indépendant du différentiel qui, lui, entraîne les deux petits pignons de commande de chaînes. Celles-ci sont enroulées sur deux grandes couronnes dentées fixées aux roues motrices. L'entretien des chaînes doit être fait soigneusement. Il est bon de les graisser chaque jour avec l'huile à moteur ; éviter l'emploi de graisse qui s'agglomère avec la terre et forme un cambouis qui durcit et use les surfaces frottantes.—

Commande par démultiplicateur.— Certain tracteurs comportent entre le différentiel et les roues motrices un système de démultiplication par pignons et couronne dentée. Quelquefois, ce système est enfermé dans une enveloppe étanche, c'est le cas des tracteurs à chenilles, par exemple. D'autres fois, les pignons entrainés par le différentiel engrènent avec deux grandes couronnes fixées aux roues et complètement extérieures.

Dans le cas de carter étanche, le graissage de ces divers engrenages est facile à assurer. Il suffit d'employer l'huile spéciale recommandée. Si les engrenages sont extérieurs, les dispositifs adoptés pour leur graissage sont assez variés. Quelquefois, il existe des godets graisseurs qui laissent écouler l'huile constamment sur les engrenages ; dans ce cas, utiliser l'huile à moteur. Mais souvent, il est nécessaire d'employer la graisse ; pour cela, se servir d'une graisse relativement épaisse qui donnera les meilleurs résultats.

Organes divers.— Combien de ressorts cassés, de ruptures de direction, de mauvais fonctionnement des freins, combien d'accidents graves, et de réparations onéreuses sont dus à une négligence dans le graissage d'organes que l'on considère comme secondaires. Ce manque d'entretien correct est onéreux et en est la cause d'une usure rapide ; c'est pourquoi il y a lieu d'apporter autant de soins à l'entretien de ces organes qu'aux autres parties du vehicule.